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# Hydrology and plankton of skipjack fishing grounds, north-east North Island, New Zealand

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National Marine Fisheries Service
2570 Dole Street
Honolulu, Hawaii

by G. Habib, G.J. Voss,
C.L. Carey, and P.M. Swanson

Fisheries Research Division
Occasional Publication: Data Series No. 7

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Occasional Publication: Data Series No. 7
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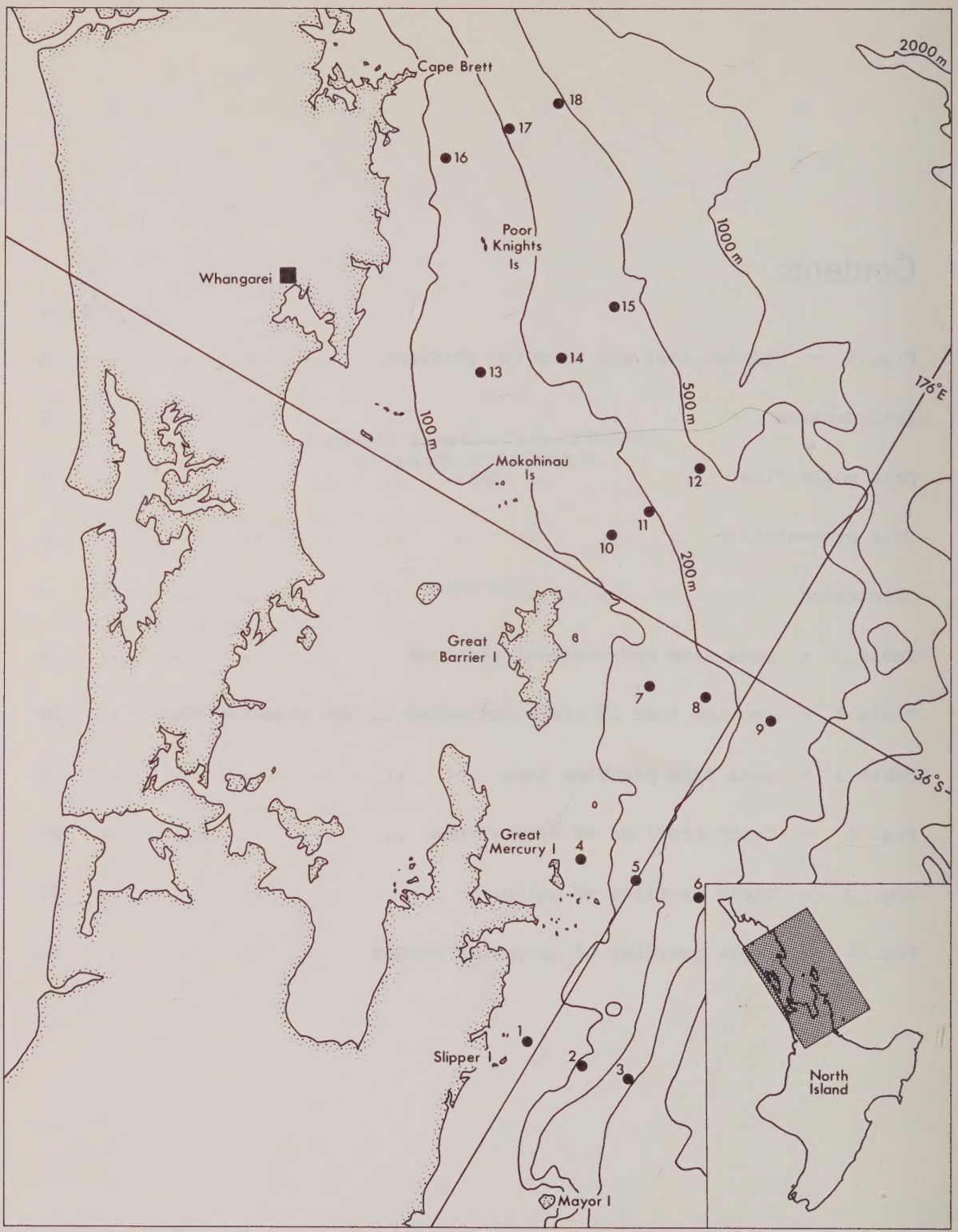


Fig. 1: Hydrological and plankton stations on skipjack fishing grounds, north-east North Island, New Zealand.

# Introduction

Each summer since late 1975, there has been a commercial purse-seine fishery for skipjack tuna (*Katsuwonus pelamis*) in New Zealand waters (see Fisheries Research Division Occasional Publications No. 11, 15, 25, 26, 29, and 36). In the 1978-79 (1979) season, a hydrological survey was undertaken near the 200-m depth contour between Mayor Island and Cape Brett on the north-east coast of the North Island (Fig. 1). This area was surveyed because it constitutes the main fishing ground for skipjack in New Zealand waters. For example, in 1977, 60% of the season's catch was taken there, and in 1978, almost 50%.

Sea surface temperature data are collected routinely by Ministry of Agriculture and Fisheries observers in the skipjack fishery, and it has been noted that skipjack distribution is associated with particular ranges of surface temperature. We decided to collect a wider range of hydrological information on the main skipjack fishing ground to gain a better understanding of the environmental factors which prevail where skipjack occur in abundance, and some insight into the reasons for observed patterns of distribution and abundance. (For details of these patterns for 1979 see Fisheries Research Division Occasional Publication No. 26.) The survey was conducted from Fisheries Research Division's research vessel *Ikatere*.

# Data collection

Measurements of water temperature, salinity, dissolved oxygen, and water clarity (transparency) were made at 18 stations (Fig. 1) each month between December 1978 and April 1979. In March a tropical cyclone limited effective sampling. In addition, the 18 stations were sampled in July-August 1980 to obtain data on the winter season hydrology in the area.

At each station, measurements were made at 30-m intervals between the surface and a depth of 120 m. Samples were collected in a Knudsen reversing bottle with a reversing thermometer (precision $\pm$ 0.1°C). Salinity was determined in the laboratory with an "Auto lab" inductive salinometer (quoted precision $\pm$ 0.003 parts per thousand). Dissolved oxygen concentration was determined by the Winkler method (quoted precision $\pm$ 0.025 ml oxygen per litre). Water clarity was measured with a standard 30-cm-diameter white Secchi disc.

At certain stations, a 1-m-diameter plankton net (mesh size 1 mm) was used in subsurface tows to collect plankton samples. These samples were sorted at the laboratory into the main taxonomic groupings and, where possible, identified to species level. The relative proportions (as percentage of wet weight of sample) of the various items were determined.

Data on weather and sea conditions were recorded at all stations.

## Data presentation

The temperature, salinity, and dissolved oxygen data are presented in vertical sections across the edge of the continental shelf, as blocks of recordings between adjacent sets of stations from in shore to off shore (Figs. 2-4). The raw data are listed in Table 1.

Data on water clarity, weather, and sea conditions are also presented in Table 1.

Taxonomic groups of animals which were present in the plankton samples are listed in Table 2, and the plankton data are in Table 3. (Note that no plankton samples were collected during the winter period of sampling.)

# Discussion

In 1979 almost half the season's skipjack catch was taken in the area of this study with about half the season's fishing effort. The catches were made in January and March. According to literature descriptions of the skipjack habitat (lower limit of water temperature 18°C, upper limit 30°C; lower limit of oxygen 3.5 ml per litre, no upper limit; no salinity limits), most surface water temperatures and about half the station 30-m-depth temperatures were favourable for skipjack in January; at 60 m most station water temperatures were too low for skipjack. There was a general extension of favourable water temperatures towards a depth of 60 m in February, a trend that was sustained into April. Unfortunately, the curtailed sampling in March limits observations that can be made on that month. All winter water temperatures were below the lower limit for skipjack. Dissolved oxygen recordings at all stations for all months were above the lower limit for skipjack.

The euphausiid *Nyctiphanes australis* was the predominant food item in skipjack from the purse-seine catches; this euphausiid was also a major component of almost half of the plankton samples.

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TABLE 1: Data from 18 hydrological stations on the skipjack tuna fishing grounds, north-east North Island, December 1978 to April 1979 and July-August 1980

*Notes to table*

Sky - B, blue sky; BC, partly cloudy; O, overcast; R, rain.

Wind - N, nil; L, light; M, moderate; S, strong.

Sea - C, calm; S, slight; M, moderate; R, rough.

x - No sample possible, too shallow.

\- - Sample lost or incorrectly obtained, or no data collected.



Inset 2*

| | Station No. | Position Lat. ° ' S | Long. ° ' E | Date | Sky | Wind | Sea | Water clarity (m) | Bottom depth (m) | Time (NZST) |
|---|---|---|---|---|---|---|---|---|---|---|
| Dec 78 | 01 | 37 00 | 175 59 | 6 | B | L | C | 9 | 69 | 0815 |
| | 02 | 36 59 | 176 09 | 6 | B | L | C | 11 | 104 | 0925 |
| | 03 | 36 57 | 176 17 | 6 | B | N | C | 13 | 360 | 1050 |
| | 04 | 36 33 | 175 48 | 6 | O | M | S | 9 | 72 | 1500 |
| | 05 | 36 31 | 176 00 | 5 | B | N | C | 12 | 122 | 1545 |
| | 06 | 36 29 | 176 10 | 5 | B | N | C | 14 | 377 | 1430 |
| | 07 | 36 07 | 175 43 | 5 | B | L | C | 14 | 128 | 0835 |
| | 08 | 36 04 | 175 52 | 5 | B | N | C | 15 | 166 | 1025 |
| | 09 | 36 02 | 176 03 | 5 | B | N | C | 16 | 191 | 1120 |
| | 10 | 35 52 | 175 24 | 13 | B | M | R | 10 | 130 | 1055 |
| | 11 | 35 46 | 175 28 | 13 | B | M | M | 12 | 172 | 1230 |
| | 12 | 35 38 | 175 32 | 13 | B | M | M | 12 | 248 | 1400 |
| | 13 | 35 41 | 174 52 | 12 | BC | M | M | 7 | 144 | 1505 |
| | 14 | 35 34 | 175 03 | 12 | R | S | R | 8 | 270 | 1330 |
| | 15 | 35 25 | 175 07 | 12 | BC | M | M | 10 | 360 | 1215 |
| | 16 | 35 18 | 174 31 | 12 | BC | M | M | 11 | 126 | 0800 |
| | 17 | 35 11 | 174 38 | 12 | B | M | S | 10 | 229 | 0845 |
| | 18 | 35 05 | 174 45 | 12 | B | L | S | 14 | 460 | 1005 |
| Jan 79 | 01 | 37 00 | 175 59 | 5 | B | L | S | 10 | 69 | 1812 |
| | 02 | 36 59 | 176 09 | 6 | B | L | S | 11 | 104 | 0655 |
| | 03 | 36 57 | 176 17 | 6 | B | M | S | 15 | 360 | 0827 |
| | 04 | 36 33 | 175 48 | 6 | B | L | S | 6 | 72 | 0640 |
| | 05 | 36 31 | 176 00 | 6 | B | L | M | 9 | 124 | 1430 |
| | 06 | 36 29 | 176 10 | 6 | B | L | M | 11 | 377 | 1315 |
| | 07 | 36 07 | 175 43 | 7 | BC | M | S | 9 | 124 | 0935 |
| | 08 | 36 04 | 175 52 | 7 | BC | M | S | 10 | 151 | 1037 |
| | 09 | 36 02 | 176 03 | 7 | B | M | S | 15 | 189 | 1215 |
| | 10 | 35 52 | 175 24 | 8 | B | M | M | 11 | 128 | 0650 |
| | 11 | 35 46 | 175 28 | 8 | BC | N | C | 12 | 172 | 0755 |
| | 12 | 35 38 | 175 32 | 8 | BC | M | M | 11 | 254 | 0919 |
| | 13 | 35 41 | 174 52 | 8 | B | L | C | 10 | 139 | 1437 |
| | 14 | 35 34 | 175 03 | 8 | B | L | C | 12 | 238 | 1307 |
| | 15 | 35 25 | 175 07 | 8 | B | L | C | 10 | 356 | 1205 |

| Water temperature (°C) by depth (m) | | | | | Salinity (parts per thousand) by depth (m) | | | | | Dissolved oxygen (ml/l) by depth (m) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 30 | 60 | 90 | 120 | 0 | 30 | 60 | 90 | 120 | 0 | 30 | 60 | 90 | 120 |
| 19.0 | 15.6 | x | x | x | 35.2 | 35.6 | x | x | x | 7.8 | 7.1 | x | x | x |
| 20.0 | 17.4 | 15.2 | 14.4 | x | 35.4 | 35.3 | 35.3 | 35.2 | x | 5.8 | 5.6 | 5.0 | 4.3 | x |
| 20.5 | 17.9 | 15.8 | 14.8 | 14.3 | 35.6 | 35.4 | 35.3 | 35.3 | 35.3 | 5.5 | 7.2 | 6.6 | 4.9 | 5.1 |
| 19.2 | 16.9 | 14.9 | x | x | 35.2 | 35.2 | 35.3 | x | x | 6.0 | 5.8 | 5.6 | x | x |
| 19.8 | 17.2 | 15.8 | 14.9 | 14.1 | 35.2 | 35.6 | 35.7 | 35.3 | - | 6.1 | 5.5 | 5.1 | 5.4 | 4.6 |
| 20.5 | 18.2 | 16.8 | 14.9 | 14.9 | 35.5 | 35.4 | 35.4 | 35.4 | 35.3 | 5.7 | 6.3 | 6.1 | 5.1 | 5.3 |
| 19.0 | 15.1 | 15.0 | 14.2 | 13.6 | 35.0 | 35.7 | - | 35.3 | 35.3 | 7.0 | 7.7 | 6.7 | 6.0 | 5.5 |
| 19.5 | 18.0 | 15.9 | 14.8 | 14.2 | 35.5 | 35.3 | 35.3 | 35.3 | 35.3 | 7.8 | 7.8 | 6.9 | 6.7 | 6.8 |
| 20.0 | 19.0 | 16.0 | 14.9 | 13.9 | 35.5 | 35.4 | 35.7 | 35.3 | 35.2 | 6.3 | 5.3 | 6.0 | 5.1 | 4.8 |
| 18.0 | 17.4 | 15.8 | 14.7 | 13.5 | 35.3 | 35.7 | 35.3 | 35.7 | 35.2 | 6.2 | 5.8 | 5.7 | 5.2 | 5.1 |
| 18.0 | 16.7 | 14.7 | 15.8 | 15.2 | 35.4 | 35.6 | 35.3 | 35.3 | 35.3 | 6.4 | 6.4 | 5.4 | 5.4 | 4.9 |
| 18.5 | 17.9 | 17.0 | 15.8 | 15.2 | 35.5 | 35.5 | 35.4 | 35.4 | 35.3 | 6.0 | 6.2 | 5.7 | 5.3 | 5.1 |
| 17.5 | 15.9 | 14.3 | 13.8 | 13.3 | 35.3 | 35.7 | - | 35.2 | 35.5 | 6.9 | 6.4 | 5.6 | 5.6 | 5.0 |
| 17.5 | 15.8 | 16.1 | 15.4 | 15.2 | 35.4 | 35.4 | 35.7 | 35.4 | 35.3 | 6.4 | 6.8 | 6.3 | 6.3 | 5.5 |
| 18.3 | 17.9 | 16.8 | 15.8 | 15.2 | 35.5 | 35.4 | 35.4 | 35.4 | 35.3 | 7.2 | 7.0 | 6.2 | 6.0 | 6.1 |
| 16.0 | 15.7 | 14.8 | 14.1 | 13.4 | 35.4 | 35.3 | 35.3 | 35.2 | 35.1 | 5.6 | 5.4 | 5.0 | 4.7 | 4.7 |
| 17.0 | 16.4 | 15.7 | 15.1 | 14.4 | 35.4 | 35.4 | 35.4 | 35.3 | 35.3 | 5.5 | 5.5 | 5.2 | 5.1 | 5.1 |
| 18.2 | 18.1 | 16.9 | 15.6 | 15.2 | 35.5 | 35.4 | 35.5 | 35.4 | 35.3 | 7.0 | 7.7 | 7.0 | 5.7 | 6.8 |
| 18.5 | 16.5 | x | x | x | 35.3 | 35.2 | x | x | x | 6.5 | 5.9 | x | x | x |
| 18.5 | 17.9 | 15.1 | 14.6 | x | 35.3 | 35.3 | 35.3 | 35.3 | x | 5.9 | 7.0 | 5.3 | 4.6 | x |
| 19.7 | 18.9 | 16.1 | 15.3 | 14.8 | 35.6 | 35.4 | 35.3 | 35.3 | 35.3 | 5.7 | 6.3 | 5.4 | 6.4 | 5.4 |
| 17.5 | 16.7 | 15.2 | x | x | 35.3 | 35.3 | 35.3 | x | x | 6.2 | 5.4 | 4.6 | x | x |
| 20.0 | 17.5 | 15.3 | 14.4 | - | 35.4 | 35.3 | 35.3 | 35.3 | - | 6.7 | 6.1 | 5.7 | 5.0 | - |
| 20.0 | 17.9 | 16.1 | 15.2 | 14.5 | 35.4 | 35.3 | 35.3 | 35.3 | 35.3 | 5.8 | 6.6 | 5.8 | 5.7 | 4.8 |
| 19.0 | 17.2 | 15.0 | 14.2 | 13.7 | 35.3 | 35.3 | 35.3 | 35.2 | 35.2 | 5.8 | 5.6 | 6.2 | 5.0 | 4.3 |
| 19.7 | 17.2 | 15.6 | 14.4 | 13.8 | 35.3 | 35.3 | 35.3 | - | 35.2 | 6.0 | 6.0 | 6.0 | 5.6 | 4.5 |
| 19.8 | 17.6 | 15.5 | 15.0 | - | 35.5 | 35.3 | 35.3 | 35.3 | - | 5.9 | 5.7 | 6.3 | 5.1 | - |
| 18.3 | 15.1 | 16.4 | 14.4 | 13.8 | 35.4 | 35.3 | 35.2 | 35.2 | 35.2 | 6.6 | 5.4 | 5.1 | 4.1 | 4.1 |
| 18.5 | 17.4 | 15.3 | 14.2 | 13.6 | 35.3 | 35.2 | 35.2 | 35.2 | 35.1 | 7.2 | 6.7 | 6.3 | 5.9 | 4.4 |
| 19.0 | 18.8 | 17.5 | 16.0 | 15.6 | 35.5 | 35.5 | 35.4 | 35.4 | 35.4 | 5.9 | 6.0 | 5.8 | 5.7 | 5.6 |
| 20.0 | 18.9 | 18.1 | 16.9 | 14.6 | 35.5 | 35.3 | 35.3 | 35.3 | 35.2 | 6.0 | 5.8 | 6.2 | 5.2 | 5.0 |
| 20.5 | 19.3 | 17.2 | 15.5 | 14.7 | 35.5 | - | 35.4 | 35.3 | 35.3 | 6.8 | 6.0 | 6.2 | 5.7 | 5.5 |
| 20.0 | 19.0 | 17.2 | 15.3 | 14.8 | 35.5 | 35.4 | 35.3 | 35.3 | 35.3 | 6.3 | 7.1 | 6.2 | 6.0 | 5.5 |

| | Station No. | Position Lat. ° ' S | Long. ° ' E | Date | Sky | Wind | Sea | Water clarity (m) | Bottom depth (m) | Time (NZST) |
|---|---|---|---|---|---|---|---|---|---|---|
| | 16 | 35 18 | 174 31 | 9 | BC | L | C | 16 | 130 | 0835 |
| | 17 | 35 11 | 174 38 | 9 | BC | L | C | 14 | 204 | 0948 |
| | 18 | 35 05 | 174 45 | 9 | O | L | C | 12 | 460 | 1130 |
| Feb 79 | 01 | 37 00 | 175 59 | 2 | B | L | M | 11 | 69 | 1751 |
| | 02 | 36 59 | 176 09 | 3 | O | M | M | 12 | 106 | 0747 |
| | 03 | 36 57 | 176 17 | 3 | O | M | M | 12 | 360 | 0930 |
| | 04 | 36 33 | 175 48 | 3 | O | S | R | 7 | 72 | 1445 |
| | 05 | 36 31 | 176 00 | 3 | O | S | R | 8 | 128 | 1530 |
| | 06 | 36 29 | 176 10 | 3 | O | S | R | 10 | 377 | 1412 |
| | 07 | 36 07 | 175 43 | 3 | O | S | R | 13 | 128 | 1315 |
| | 08 | 36 04 | 175 52 | 3 | O | S | R | 12 | 154 | 1235 |
| | 09 | 36 02 | 176 03 | 3 | O | S | R | 12 | 192 | 1400 |
| | 10 | 35 52 | 175 24 | 6 | O | M | M | 13 | 128 | 0745 |
| | 11 | 35 46 | 175 28 | 6 | O | M | M | 15 | 171 | 0845 |
| | 12 | 35 38 | 175 32 | 6 | O | M | R | 15 | 254 | 1000 |
| | 13 | 35 41 | 174 52 | 6 | B | S | M | 15 | 139 | 1515 |
| | 14 | 35 34 | 175 03 | 6 | BC | S | M | 12 | 238 | 1345 |
| | 15 | 35 25 | 175 07 | 6 | O | M | M | 12 | 356 | 1250 |
| | 16 | 35 18 | 174 31 | 7 | BC | M | M | 10 | 130 | 0755 |
| | 17 | 35 11 | 174 38 | 7 | O | M | M | 16 | 215 | 0921 |
| | 18 | 35 05 | 174 45 | 7 | BC | S | M | 17 | 460 | 1040 |
| Mar 79 | 01 | 37 00 | 175 59 | 11 | BC | L | S | 8 | 54 | 1050 |
| | 02 | 36 59 | 176 09 | 11 | BC | M | M | 12 | 108 | 1155 |
| | 03 | 36 57 | 176 17 | 11 | BC | M | M | 14 | 360 | 1330 |
| | 04 | 36 33 | 175 48 | 9 | R | S | M | 10 | 73 | 0800 |
| | 05 | 36 31 | 176 00 | 9 | R | S | R | 13 | 128 | 0900 |
| | Stations 06 to 18 no data; bad weather prevented sampling | | | | | | | | | |
| | 01 | 37 00 | 175 59 | 28 | BC | L | S | 6 | 55 | 1747 |
| | 02 | 36 59 | 176 09 | 28 | BC | L | S | - | 107 | 1855 |
| | 03 | 36 57 | 176 17 | 28 | BC | L | S | - | 360 | 2000 |
| | 04 | 36 33 | 175 48 | 29 | O | L | S | 11 | 73 | 0800 |

| Water temperature (°C) by depth (m) | | | | | Salinity (parts per thousand) by depth (m) | | | | | Dissolved oxygen (ml/l) by depth (m) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 30 | 60 | 90 | 120 | 0 | 30 | 60 | 90 | 120 | 0 | 30 | 60 | 90 | 120 |
| 19.0 | 19.0 | 16.5 | 14.4 | 13.7 | 35.3 | 35.3 | 35.2 | 35.2 | 35.2 | 6.6 | 6.6 | 6.1 | 5.8 | 5.2 |
| 20.0 | 18.1 | 16.3 | 14.9 | 14.3 | 35.5 | 35.4 | 35.3 | 35.3 | 35.2 | 6.5 | 5.9 | 7.6 | 6.1 | 5.3 |
| 19.5 | 18.5 | 16.2 | 15.4 | 14.6 | 35.4 | - | 35.3 | 35.3 | 35.2 | 6.4 | 6.4 | 6.0 | 6.0 | 5.9 |
| 21.5 | 20.8 | x | x | x | 35.4 | 35.4 | x | x | x | - | 6.2 | x | x | x |
| 20.8 | 20.9 | 19.0 | 15.4 | x | - | 35.4 | 35.3 | 35.3 | x | 7.4 | 5.9 | 5.7 | 5.4 | x |
| 21.0 | 20.9 | 17.7 | 15.7 | 14.9 | 35.6 | 35.5 | 35.4 | 35.4 | 35.3 | 5.8 | 6.4 | 5.7 | 5.8 | 5.6 |
| 20.2 | 19.3 | 17.1 | x | x | 35.3 | 35.3 | 35.3 | x | x | 6.2 | 5.6 | 5.8 | x | x |
| 21.0 | 20.0 | 16.2 | 15.0 | 14.6 | 35.4 | 35.3 | 35.3 | 35.3 | 35.3 | 5.5 | 6.6 | 5.9 | 5.9 | 4.4 |
| 21.0 | 20.8 | 17.6 | 15.8 | - | 35.5 | 35.4 | 35.3 | 35.3 | - | 7.7 | 5.7 | 5.6 | 5.0 | - |
| 20.4 | 19.9 | 16.6 | 14.8 | - | 34.7 | 35.3 | 35.3 | - | - | 5.9 | 5.7 | 5.9 | 4.6 | - |
| 21.2 | 20.6 | 16.4 | 15.1 | 13.4 | 35.0 | 35.4 | 35.3 | 35.3 | 35.2 | 5.4 | 6.3 | 6.0 | 5.9 | 6.0 |
| 21.3 | 20.4 | 16.4 | 14.9 | 14.6 | 35.0 | 35.4 | 35.3 | 35.3 | 35.3 | 5.4 | 7.6 | 6.2 | 5.2 | 4.7 |
| 21.2 | 20.7 | 18.6 | 15.6 | 14.7 | 35.4 | 35.5 | 35.3 | 35.3 | 35.2 | 5.3 | 5.6 | 6.4 | 5.6 | 5.2 |
| 21.2 | 20.2 | 18.9 | 16.4 | 15.1 | 35.4 | 35.4 | 35.4 | 35.3 | 35.3 | 5.6 | 5.6 | 5.5 | 4.9 | 4.6 |
| 21.5 | 20.9 | 18.7 | 16.4 | 15.4 | 35.3 | 35.5 | 35.4 | 35.4 | 35.3 | 6.9 | 6.8 | 5.9 | 5.8 | - |
| 20.9 | 20.0 | 17.7 | 15.4 | 14.4 | 35.4 | 35.4 | 35.3 | 35.2 | 35.2 | 6.4 | 6.7 | 6.5 | 5.9 | 5.6 |
| 20.9 | 19.8 | 17.6 | 15.5 | 15.3 | 35.4 | 35.4 | 35.3 | 35.3 | 35.2 | 6.3 | 6.9 | 5.8 | 5.0 | 4.6 |
| 20.9 | 19.8 | 17.3 | 15.9 | 15.6 | 35.4 | 35.4 | 35.4 | 35.3 | 35.3 | 6.6 | 6.6 | 6.4 | 5.7 | 5.6 |
| 21.2 | 19.3 | 17.1 | 15.0 | 14.6 | 35.5 | 35.4 | 35.3 | 35.2 | 35.2 | 6.7 | 5.6 | 5.6 | 5.2 | 5.0 |
| 21.3 | 20.3 | 17.9 | 14.7 | 13.7 | 35.5 | 35.4 | 35.3 | 35.2 | 35.2 | 5.7 | 6.9 | 6.0 | 5.0 | 4.9 |
| 21.5 | 20.9 | 18.9 | 15.7 | 15.1 | 35.5 | 35.4 | 35.3 | 35.3 | 35.2 | 6.8 | 7.0 | 5.6 | 5.5 | 5.5 |
| 20.5 | 19.2 | x | x | x | 33.6 | 35.2 | x | x | x | 6.7 | 5.8 | x | x | x |
| 20.5 | 20.2 | 16.6 | 14.9 | x | 35.2 | 35.3 | 35.2 | 35.3 | x | 5.7 | 5.6 | 4.5 | 5.2 | x |
| 20.9 | 20.3 | 17.1 | 15.2 | 14.7 | 35.3 | 35.4 | 35.3 | 35.3 | 35.3 | 6.4 | 5.7 | 5.3 | 5.2 | 5.2 |
| 20.2 | 19.2 | 17.5 | x | x | 35.3 | 35.3 | 35.3 | x | x | 5.9 | 4.8 | 5.0 | x | x |
| 20.8 | 19.3 | 17.7 | 15.7 | 14.8 | 35.4 | 35.3 | 35.3 | 35.3 | 35.3 | 7.2 | 6.1 | 5.8 | 5.6 | 5.5 |
| 21.3 | 20.2 | x | x | x | 33.7 | 35.0 | x | x | x | 5.4 | 6.6 | x | x | x |
| 21.4 | 20.3 | 18.2 | 18.0 | x | 34.1 | 35.1 | 35.2 | 35.2 | x | 6.4 | 5.5 | 5.3 | 5.5 | x |
| 21.2 | 21.0 | 19.3 | 16.5 | - | 34.9 | 35.4 | 35.4 | 35.3 | - | 5.8 | 5.6 | 5.5 | - | - |
| 20.7 | 19.8 | 18.3 | x | x | 34.4 | 35.2 | 35.3 | x | x | 5.6 | 4.5 | 4.1 | x | x |

| | Station No. | Position Lat. ° ' S | Long. ° ' E | Date | Sky | Wind | Sea | Water clarity (m) | Bottom depth (m) | Time (NZST) |
|---|---|---|---|---|---|---|---|---|---|---|
| | 05 | 36 31 | 176 00 | 29 | O | N | C | 15 | 128 | 0853 |
| | 06 | 36 29 | 176 10 | 29 | O | L | C | 16 | 377 | 1030 |
| | 07 | 36 07 | 175 43 | 29 | O | L | C | 15 | 126 | 1545 |
| | 08 | 36 04 | 175 52 | 29 | O | N | C | 15 | 154 | 1425 |
| | 09 | 36 02 | 176 03 | 29 | O | N | C | 15 | 192 | 1309 |
| | 10 | 35 52 | 175 24 | 29 | O | N | C | - | 128 | 1809 |
| | 11 | 35 46 | 175 28 | 29 | O | N | C | - | 172 | 1926 |
| | 12 | 35 38 | 175 32 | 29 | O | N | C | - | 254 | 2040 |
| Apr 79 | 13 | 35 41 | 174 52 | 3 | B | N | C | 13 | 146 | 1525 |
| | 14 | 35 34 | 175 03 | 3 | B | L | S | 13 | 238 | 1420 |
| | 15 | 35 25 | 175 07 | 3 | BC | L | S | 14 | 357 | 1315 |
| | 16 | 35 18 | 174 31 | 3 | O | M | M | 12 | 143 | 0730 |
| | 17 | 35 11 | 174 38 | 3 | BC | M | M | 10 | 205 | 0845 |
| | 18 | 35 05 | 174 45 | 3 | BC | M | M | 14 | 460 | 1013 |
| Jul 80 | 01 | 37 00 | 175 59 | 30 | BC | L | S | 10 | 69 | 0825 |
| | 02 | 36 59 | 176 09 | 30 | BC | L | S | 12 | 104 | 0943 |
| | 03 | 36 57 | 176 17 | 30 | B | L | S | 15 | 360 | 1107 |
| | 04 | 36 33 | 175 48 | 31 | R | M | M | 13 | 72 | 1227 |
| | 05 | 36 31 | 176 00 | 30 | B | M | M | 10 | 122 | 1650 |
| | 06 | 36 29 | 176 10 | 30 | B | M | M | 14 | 377 | 1530 |
| | 07 | 36 07 | 175 43 | 31 | O | M | M | 13 | 128 | 1540 |
| | 08 | 36 04 | 175 52 | 31 | O | S | R | 14 | 166 | 1645 |
| | 09 | 36 02 | 176 03 | 31 | R | S | R | - | 191 | 1555 |
| Aug 80 | 10 | 35 52 | 175 24 | 5 | B | M | M | 13 | 130 | 1540 |
| | 11 | 35 46 | 175 28 | 5 | B | S | M | 12 | 172 | 1640 |
| | 12 | 35 38 | 175 32 | 5 | B | S | M | - | 248 | 1752 |
| | 13 | 35 41 | 174 52 | 6 | B | L | S | 15 | 144 | 1210 |
| | 14 | 35 34 | 175 03 | 6 | B | L | S | 16 | 270 | 1330 |
| | 15 | 35 25 | 175 07 | 6 | B | L | S | 13 | 360 | 1455 |
| | 16 | 35 18 | 174 31 | 6 | BC | M | M | - | 126 | 2018 |
| | 17 | 35 11 | 174 38 | 6 | BC | M | M | - | 229 | 1855 |
| | 18 | 35 05 | 174 45 | 6 | B | M | M | - | 460 | 1758 |

| Water temperature (°C) by depth (m) | | | | | Salinity (parts per thousand) by depth (m) | | | | | Dissolved oxygen (ml/l) by depth (m) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 30 | 60 | 90 | 120 | 0 | 30 | 60 | 90 | 120 | 0 | 30 | 60 | 90 | 120 |
| 20.8 | 19.9 | 19.4 | 15.6 | 14.5 | 34.3 | 35.2 | 35.3 | 35.3 | 35.2 | 5.5 | 5.6 | 5.3 | 4.9 | 4.1 |
| 21.6 | 21.4 | 15.6 | - | 18.2 | 35.6 | 35.5 | 35.4 | 35.3 | 35.4 | 5.2 | 5.1 | 6.6 | 4.8 | 4.8 |
| 21.2 | 20.5 | 18.9 | 16.4 | 14.3 | 35.4 | 35.4 | 35.3 | 35.3 | 35.2 | 5.4 | 6.3 | 4.9 | 4.9 | 4.4 |
| 20.9 | 20.7 | 18.3 | 16.2 | 14.8 | 35.1 | 35.3 | 35.3 | 35.3 | 35.2 | 6.7 | 6.4 | 4.5 | 4.5 | 4.3 |
| 21.2 | 20.5 | 18.0 | 16.1 | 15.1 | 35.4 | 35.4 | 35.3 | 35.3 | 35.3 | 5.2 | 6.6 | 5.9 | 4.7 | 5.0 |
| 20.7 | 20.2 | 19.1 | 15.6 | 14.3 | 35.2 | 35.2 | 35.2 | 35.2 | 35.2 | 7.1 | 5.8 | 5.3 | 4.9 | 4.7 |
| 21.1 | 18.8 | 16.8 | 15.3 | 14.7 | 35.3 | 35.3 | 35.3 | 35.3 | 35.3 | 6.9 | 5.7 | 4.9 | 5.3 | 5.4 |
| 21.3 | 21.3 | 20.5 | 17.0 | 15.0 | 35.5 | 35.5 | 35.5 | 35.3 | 35.3 | 6.2 | 6.6 | 5.9 | 6.0 | 4.9 |
| 21.0 | 19.7 | 18.9 | 16.4 | - | 35.3 | 35.3 | 35.3 | 35.3 | 35.3 | 5.6 | 5.5 | 4.9 | 5.0 | 4.9 |
| 20.2 | 20.0 | 18.1 | 16.3 | - | 35.3 | 35.3 | 35.3 | 35.3 | 35.3 | 6.6 | 6.0 | 5.2 | 4.7 | 5.0 |
| 20.2 | 19.9 | 18.5 | 16.2 | - | 35.3 | 35.3 | 35.3 | 35.3 | 35.3 | 6.6 | 6.1 | 4.7 | 4.7 | 4.8 |
| 20.1 | 19.7 | 19.9 | 17.8 | 15.7 | 35.3 | 35.3 | 35.4 | 35.3 | 35.2 | 6.8 | 5.5 | 5.8 | 4.9 | 5.0 |
| 20.2 | 19.8 | 19.9 | 17.3 | 16.3 | 35.3 | 35.3 | 35.3 | 35.3 | 35.3 | 6.2 | 6.1 | 5.1 | 4.8 | 5.0 |
| 20.2 | 20.0 | 19.5 | 16.8 | 20.1 | 35.4 | 35.3 | 35.3 | 35.3 | 35.4 | 5.9 | 5.6 | 5.3 | - | 5.6 |
| | | | | | | | | | | | | | | |
| 13.5 | 13.5 | x | x | x | 35.1 | 35.1 | x | x | x | 5.8 | 6.4 | x | x | x |
| 14.5 | 14.1 | 14.3 | 14.3 | x | 35.3 | 35.2 | 35.3 | 35.3 | x | 5.2 | 6.7 | 6.0 | 5.3 | x |
| 15.2 | 15.1 | 15.1 | 15.1 | 15.0 | 35.4 | 35.4 | 35.4 | 35.4 | 35.4 | 5.0 | 6.0 | 6.8 | 6.6 | 7.1 |
| 14.5 | 14.8 | 14.3 | x | x | 35.2 | 35.2 | 35.2 | x | x | 5.2 | 6.7 | 5.4 | x | x |
| 15.0 | 14.8 | 14.8 | 14.6 | 14.5 | 35.4 | - | 35.3 | 35.3 | 35.3 | 6.3 | 6.6 | 6.0 | 9.6 | 7.5 |
| 15.0 | 15.0 | 15.0 | 15.0 | 14.9 | 35.4 | 35.4 | 35.4 | 35.4 | 35.3 | 5.5 | 5.0 | 5.8 | 5.7 | 5.2 |
| 14.7 | 14.7 | 14.7 | 14.7 | 14.7 | 35.3 | 35.3 | 35.3 | 35.3 | 35.3 | 6.0 | 6.6 | 6.0 | 5.8 | 5.8 |
| 14.7 | 14.6 | 14.6 | 14.6 | 14.6 | 35.3 | 35.3 | 35.3 | 35.2 | 35.3 | 6.0 | 6.5 | 7.1 | 6.5 | 5.3 |
| 14.6 | 14.7 | 14.6 | 14.6 | 14.6 | 35.3 | 35.3 | 35.3 | 35.3 | 35.3 | 6.3 | 5.6 | 6.4 | 6.3 | 6.8 |
| 14.5 | 14.6 | 14.5 | 15.3 | - | 35.4 | 35.3 | 35.3 | 35.3 | 35.3 | 6.0 | 5.9 | 5.1 | 5.6 | 4.6 |
| 14.7 | - | 15.7 | 14.7 | 14.6 | 35.3 | 35.3 | 35.3 | 35.3 | 35.3 | 6.4 | 5.3 | 6.3 | 6.0 | 5.1 |
| 14.8 | 14.6 | 14.8 | 14.8 | 14.8 | 35.4 | 35.3 | 35.3 | 35.3 | 35.3 | 5.8 | 5.5 | 5.7 | 6.0 | 6.0 |
| 14.9 | 14.7 | - | 14.7 | 14.4 | 35.3 | 35.3 | 35.3 | 35.4 | 35.2 | 5.3 | 5.7 | 6.5 | 6.4 | 5.2 |
| 14.8 | 14.8 | 14.8 | 14.7 | 14.7 | 35.4 | 35.3 | 35.3 | 35.3 | 35.3 | 6.9 | 6.8 | 5.5 | 6.7 | 5.9 |
| 14.9 | 14.9 | 14.8 | 14.8 | 14.8 | 35.3 | 35.4 | 35.3 | 35.3 | 35.3 | 5.6 | 5.4 | 5.5 | 6.7 | 6.2 |
| 15.5 | 15.2 | 15.2 | 15.2 | 15.2 | 35.4 | 35.4 | 35.4 | 35.4 | 35.3 | 4.5 | 4.3 | 6.5 | 6.3 | 5.9 |
| 15.6 | 15.6 | 15.6 | 15.5 | 15.4 | 35.5 | 35.4 | 35.4 | 35.4 | 35.4 | 5.2 | 5.7 | 6.4 | 5.8 | 6.3 |
| 15.9 | 16.0 | 15.9 | 15.4 | 15.1 | 35.5 | 35.5 | 35.4 | 35.4 | 35.3 | 5.3 | 5.2 | 5.4 | 4.9 | 6.0 |



Inset 3

TABLE 2: Species list, in taxonomic order, of items collected in the plankton tows during the hydrological survey of the north-east coast of the North Island

Phylum Coelenterata
- Class Hydrozoa
- Order Siphonophora
  - *Velella* sp.

Phylum Annelida
- Class Polychaeta
  - Unidentified polychaetes

Phylum Arthropoda
- Class Crustacea
- Subclass Copepoda
  - Unidentified copepods
- Subclass Ostracoda
  - Unidentified ostracods
- Subclass Malacostraca
- Order Stomatopoda
  - *Squilla* sp.
  - Unidentified stomatopods
- Order Peracarida
- Suborder Mysidacea
  - Unidentified mysids
- Suborder Amphipoda
  - *Vibilia stebbingi*
  - *Vibilia* sp.
  - *Paraphronima* sp.
  - *Phronima sedentaria*
  - *Oxycephalus* sp.
  - *Hyperia spinigera*
  - *Pronoe* sp.
  - *Anchylomera* sp.
- Order Eucarida
- Suborder Euphausiacea
  - *Nyctiphanes australis*
  - *Thysanoessa gregaria*
  - *Thysanoessa pava*
- Suborder Decapoda
  - Unidentified zoea and megalopa
  - Unidentified phyllosoma
  - *Ibacus alticrenatus* (phyllosoma)

Phylum Mollusca
- Class Gastropoda
- Order Pteropoda
  - Unidentified pteropods
- Class Cephalopoda
- Order Dibranchia
- Suborder Decapoda
  - Unidentified squid larvae and juveniles

Phylum Chaetognatha
- Unidentified chaetognaths

Phylum Chordata
- Class Thaliacea
- Order Salpidae
  - *Salpa* sp.
  - Unidentified salps
- Class Actinopterygii
- Superorder Teleostei
  - Unidentified eggs and larvae

TABLE 3: Data from plankton tows during the hydrological survey of the north-east coast of the North Island



Inset 3*

| | |
|---|---|
| Station No. | D 02 |
| Date | 6.12.78 |
| Bottom depth (m) | 166 |
| Time down (NZST) | 1025 |
| Depth of tow (m) | 100 |
| Time towed (minutes) | 15 |
| Time up (NZST) | 1050 |
| Sample size | medium |
| Species (by %) | Copepoda: unid. copepods (0.2%) |
| | Stomatopoda: *Squilla* sp. (4.0%) |
| | Amphipoda: *Vibilia* sp. (7.2%) |
| | *Paraphronima* sp. (0.3%) |
| | *Phronima sedentaria* (1.0%) |
| | *Hyperia spinigera* (1.9%) |
| | Euphausiacea: *Nyctiphanes australis* (22.8%) |
| | Eucarida, Decapoda: unid. megalopa (0.5%) |
| | Dibranchia, Decapoda: unid. squid larvae (0.3%) |
| | Chaetognatha: unid. chaetognaths (3.0%) |
| | Salpidae: unid. salps (58.8%) |

| | |
|---|---|
| Station No. | D 14 |
| Date | 12.12.78 |
| Bottom depth (m) | 270 |
| Time down (NZST) | 1340 |
| Depth of tow (m) | 100 |
| Time towed (minutes) | 11 |
| Time up (NZST) | 1405 |
| Sample size | small - medium |
| Species (by %) | Copepoda: unid. copepods (5.5%) |
| | Ostracoda: unid. ostracods (0.5%) |
| | Amphipoda: *Vibilia* sp. (15.0%) |
| | *Phronima sedentaria* (14.0%) |
| | *Hyperia spinigera* (1.0%) |
| | Euphausiacea: *Thysanoessa pava* (34.0%) |
| | Salpidae: *Salpa* sp. (15.0%) |
| | Teleostei: unid. eggs (15.0%) |

D 05
5.12.78
120
1550
70
20
1615
small
Teleostei: unid. eggs and larvae (100%)

D 08
5.12.78
104
0934
76
15
1000
medium
Copepoda: unid. copepods (2.0%)
Stomatopoda: unid. stomatopods (2.0%)
Amphipoda: *Vibilia* sp. (31.2%)
*Phronima sedentaria* (1.0%)
*Hyperia spinigera* (1.0%)
Salpidae: *Salpa* sp. (35.0%)
Teleostei: unid. eggs and larvae (28.0%)

D 17
12.12.78
229
0845
100
16
0910
medium
Stomatopoda: unid. stomatopods (0.3%)
Amphipoda: *Vibilia* sp. (50.0%)
*Phronima sedentaria* (1.0%)
Euphausiacea: *Nyctiphanes australis* (2.0%)
Eucarida, Decapoda: unid. zoea and megalopa (0.3%)
Salpidae: *Salpa* sp. (38.1%)
Teleostei: unid. eggs and larvae (3.0%)

J 02
6.1.79
151
1050
90
14
1115
medium
Copepoda: unid. copepods (0.8%)
Ostracoda: unid. ostracods (0.3%)
Stomatopoda: unid. stomatopods (0.1%)
Amphipoda: *Vibilia* sp. (1.3%)
*Phronima sedentaria* (1.2%)
Euphausiacea: *Nyctiphanes australis* (39.3%)
*Thysanoessa gregaria* (5.2%)
Eucarida, Decapoda: unid. larvae (4.0%)
unid. phyllosoma (9.0%)
Salpidae: unid. salps (5.0%)
Teleostei: unid. eggs and larvae (33.8%)

| | |
|---|---|
| Station No. | J 05 |
| Date | 6.1.79 |
| Bottom depth (m) | 124 |
| Time down (NZST) | 1442 |
| Depth of tow (m) | 85 |
| Time towed (minutes) | 15 |
| Time up (NZST) | 1505 |
| Sample size | medium |
| Species (by %) | Copepoda: unid. copepods (4.0%) |
| | Stomatopoda: unid. stomatopods (3.0%) |
| | Amphipoda: *Vibilia* sp. (0.3%) |
| | *Phronima sedentaria* (0.2%) |
| | Euphausiacea: *Nyctiphanes australis* (46.6%) |
| | *Thysanoessa pava* (6.4%) |
| | Eucarida, Decapoda: unid. zoea (6.5%) |
| | Salpidae: *Salpa* sp. (2.0%) |
| | Teleostei: unid. eggs and larvae (31.0%) |

| | |
|---|---|
| Station No. | J 14 |
| Date | 8.1.79 |
| Bottom depth (m) | 304 |
| Time down (NZST) | 1320 |
| Depth of tow (m) | 90 |
| Time towed (minutes) | 17 |
| Time up (NZST) | 1345 |
| Sample size | small - medium |
| Species (by %) | Stomatopoda: unid. stomatopods (5.0%) |
| | Amphipoda: *Vibilia* sp. (50.0%) |
| | Euphausiacea: *Thysanoessa pava* (10.0%) |
| | Salpidae: *Salpa* sp. (32.0%) |
| | Teleostei: unid. eggs and larvae (3.0%) |

J 08

7.1.79

104

0709

22

19

0735

medium

Copepoda: unid. copepods (2.0%)

Stomatopoda: unid. stomatopods (5.0%)

Euphausiacea: *Nyctiphanes australis* (31.5%)

*Thysanoessa gregaria* (3.5%)

Eucarida, Decapoda: unid. zoea and megalopa (18.0%)

Teleostei: unid. eggs and larvae (40.0%)

J 11

8.1.79

169

0805

90

16

0833

small - medium

Copepoda: unid. copepods (8.0%)

Ostracoda: unid. ostracods (1.0%)

Stomatopoda: unid. stomatopods (9.0%)

Amphipoda: *Vibilia* sp. (0.2%)

*Paraphronima* sp. (0.2%)

*Phronima sedentaria* (1.2%)

*Hyperia spinigera* (1.8%)

*Pronoe* sp. (0.6%)

Euphausiacea: *Nyctiphanes australis* (34.6%)

*Thysanoessa pava* (0.4%)

Eucarida, Decapoda: unid. zoea (8.0%)

Salpidae: *Salpa* sp. (3.0%)

Teleostei: unid. eggs and larvae (32.0%)

J 17

9.1.79

202

1000

90

15

1027

small - medium

Amphipoda: *Vibilia stebbingi* (70.0%)

Salpidae: *Salpa* sp. (30.0%)

F 02

3.2.79

151

1245

90

16

1309

small

Stomatopoda: unid. stomatopods (20.0%)

Salpidae: *Salpa* sp. (30.0%)

Teleostei: unid. eggs (50.0%)

| | |
|---|---|
| Station No. | F 05 |
| Date | 3.2.79 |
| Bottom depth (m) | 126 |
| Time down (NZST) | 1542 |
| Depth of tow (m) | 90 |
| Time towed (minutes) | 19 |
| Time up (NZST) | 1609 |
| Sample size | medium |
| Species (by %) | Siphonophora: *Velella* sp. (0.5%) |
| | Copepoda: unid. copepods (8.5%) |
| | Stomatopoda: unid. stomatopods (24.0%) |
| | Amphipoda: *Vibilia* sp. (0.5%) |
| | Eucarida, Decapoda: *Ibacus alticrenatus* (phyllosoma) (1.0%) |
| | Salpidae: *Salpa* sp. (1.0%) |
| | Teleostei: unid. eggs (64.5%) |

| | |
|---|---|
| Station No. | F 14 |
| Date | 6.2.79 |
| Bottom depth (m) | 234 |
| Time down (NZST) | 1500 |
| Depth of tow (m) | 90 |
| Time towed (minutes) | 12 |
| Time up (NZST) | 1523 |
| Sample size | medium - large |
| Species (by %) | Stomatopoda: unid. stomatopods (1.0%) |
| | Amphipoda: *Vibilia* sp. (8.0%) |
| | *Phronima sedentaria* (1.0%) |
| | *Hyperia spinigera* (1.0%) |
| | Euphausiacea: *Thysanoessa pava* (6.0%) |
| | Eucarida, Decapoda: *Ibacus alticrenatus* (phyllosoma) (2.0%) |
| | Pteropoda: unid. pteropods (3.0%) |
| | Dibranchia, Decapoda: unid. squid larvae (1.0%) |
| | Salpidae: *Salpa* sp. (70.0%) |
| | Teleostei: unid. eggs (7.0%) |

F 08

3.2.79

104

0800

90

15

0825

small

| | | |
|---|---|---|
| Siphonophora: | *Velella* sp. | (15.0%) |
| Stomatopoda: | unid. stomatopods | (10.0%) |
| Eucarida, Decapoda: | unid. zoea | (15.0%) |
| Salpidae: | *Salpa* sp. | (10.0%) |
| Teleostei: | unid. eggs and larvae | (50.0%) |

F 11

6.2.79

169

0856

90

15

0919

large

| | | |
|---|---|---|
| Polychaeta: | unid. polychaetes | (0.1%) |
| Amphipoda: | *Vibilia* sp. | (12.0%) |
| | *Phronima sedentaria* | (6.0%) |
| | *Oxycephalus* sp. | (0.4%) |
| | *Hyperia spinigera* | (1.0%) |
| | *Pronoe* sp. | (0.8%) |
| | *Anchylomera* sp. | (0.2%) |
| Euphausiacea: | *Nyctiphanes australis* | (30.0%) |
| Eucarida, Decapoda: | *Ibacus alticrenatus* (phyllosoma) | (2.0%) |
| Salpidae: | *Salpa* sp. | (42.5%) |
| Teleostei: | unid. eggs and larvae | (5.0%) |

F 17

7.2.79

202

0933

90

16

0958

large

| | | |
|---|---|---|
| Polychaeta: | unid. polychaetes | (0.2%) |
| Copepoda: | unid. copepods | (0.3%) |
| Stomatopoda: | unid. stomatopods | (8.0%) |
| Amphipoda: | *Vibilia* sp. | (0.5%) |
| | *Phronima sedentaria* | (4.0%) |
| | *Oxycephalus* sp. | (0.5%) |
| | *Hyperia spinigera* | (1.0%) |
| | *Pronoe* sp. | (1.0%) |
| Euphausiacea: | *Thysanoessa pava* | (23.0%) |
| Eucarida, Decapoda: | unid. zoea and megalopa | (1.5%) |
| Dibranchia, Decapoda: | unid. squid juveniles | (4.0%) |
| Salpidae: | *Salpa* sp. | (54.0%) |
| Teleostei: | unid. eggs and larvae | (2.0%) |

M 05

9.3.79

126

0919

90

14

0949

medium

| | | |
|---|---|---|
| Copepoda: | unid. copepods | (2.0%) |
| Stomatopoda: | unid. stomatopods | (5.0%) |
| Amphipoda: | *Phronima sedentaria* | (0.5%) |
| Euphausiacea: | *Nyctiphanes australis* | (35.0%) |
| Eucarida, Decapoda: | unid. zoea | (15.0%) |
| Salpidae: | *Salpa* sp. | (17.0%) |
| Teleostei: | unid. eggs and larvae | (25.5%) |

| | | |
|---|---|---|
| Station No. | A 02 | |
| Date | 28.3.79 | |
| Bottom depth (m) | 151 | |
| Time down (NZST) | 1435 | |
| Depth of tow (m) | 90 | |
| Time towed (minutes) | 15 | |
| Time up (NZST) | 1500 | |
| Sample size | small | |
| Species (by %) | Stomatopoda: *Squilla* sp. | (5.0%) |
| | Amphipoda: *Vibilia* sp. | (0.5%) |
| | *Phronima sedentaria* | (0.5%) |
| | *Hyperia spinigera* | (4.0%) |
| | Eucarida, Decapoda: unid. zoea and megalopa | (10.0%) |
| | Dibranchia, Decapoda: unid. squid larvae | (1.0%) |
| | Salpidae: *Salpa* sp. | (20.0%) |
| | Teleostei: unid. eggs and larvae | (59.0%) |

| | | |
|---|---|---|
| Station No. | A 11 | |
| Date | 29.3.79 | |
| Bottom depth (m) | 169 | |
| Time down (NZST) | 1930 | |
| Depth of tow (m) | 90 | |
| Time towed (minutes) | 14 | |
| Time up (NZST) | 1950 | |
| Sample size | large | |
| Species (by %) | Euphausiacea: *Nyctiphanes australis* | (100%) |

A 05

29.3.79

126

0912

90

17

0936

small

Stomatopoda: *Squilla* sp. (20.0%)

Mysidacea: unid. mysids (30.0%)

Euphausiacea: *Nyctiphanes australis* (16.0%)

Teleostei: unid. eggs and larvae (34.0%)

A 08

29.3.79

104

1855

90

16

1920

large

Euphausiacea: *Nyctiphanes australis* (100%)

A 14

3.4.79

234

1433

90

13

1455

medium

Stomatopoda: *Squilla* sp. (3.5%)

Amphipoda: *Hyperia spinigera* (1.5%)

Euphausiacea: *Nyctiphanes australis* (46.0%)

Eucarida, Decapoda: unid. zoea (8.0%)

Salpidae: *Salpa* sp. (10.0%)

Teleostei: unid. eggs and larvae (31.0%)

A 17

3.4.79

202

0855

90

15

0921

medium

Stomatopoda: *Squilla* sp. (20.0%)

Mysidacea: unid. mysids (3.0%)

Euphausiacea: *Nyctiphanes australis* (40.0%)

Eucarida, Decapoda: unid. zoea and megalopa (12.0%)

Teleostei: unid. eggs and larvae (25.0%)

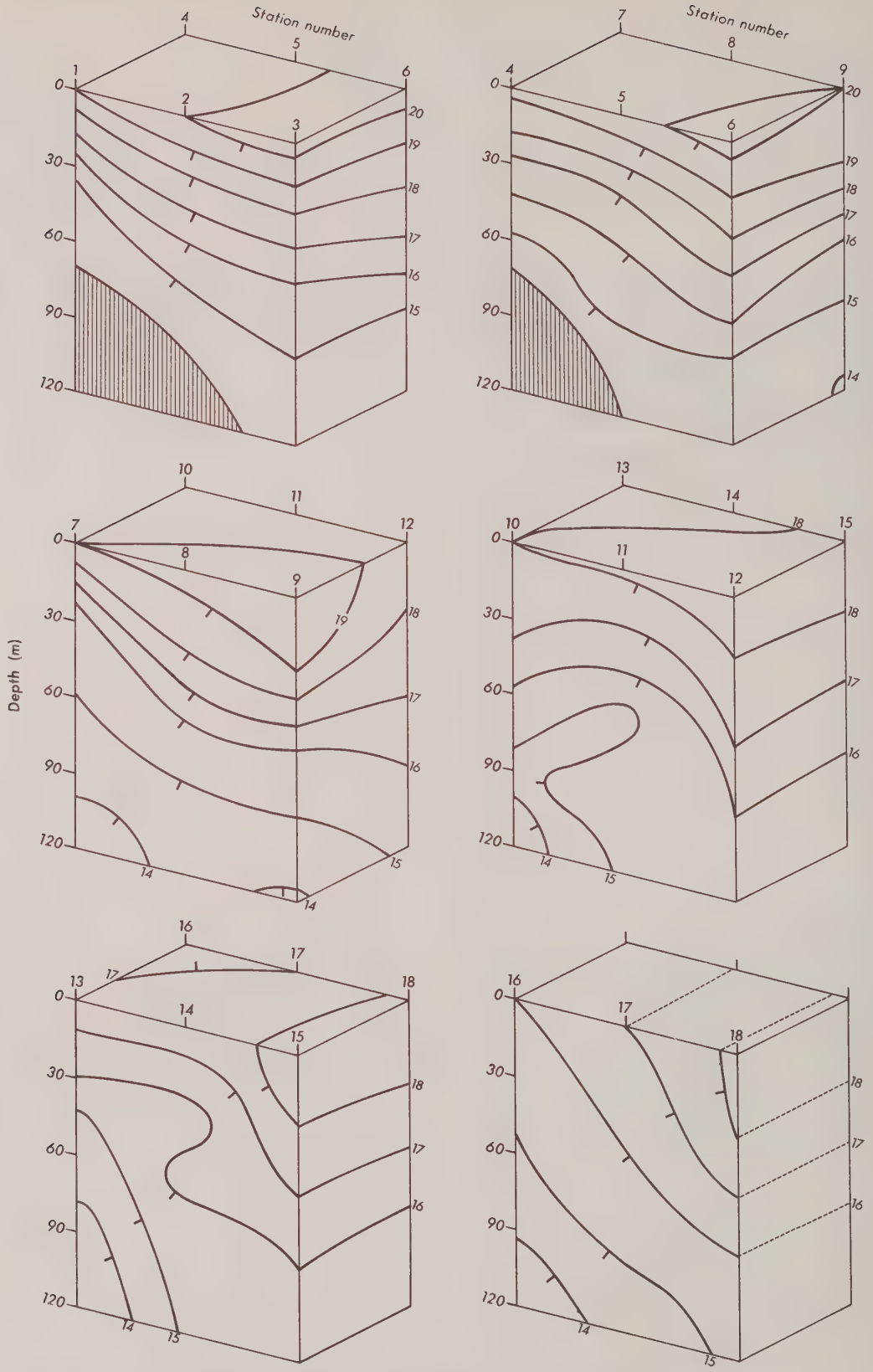


Fig. 2a: Depth profiles of temperature (°c) at stations on skipjack fishing grounds, December. Hatched area represents sea bed.

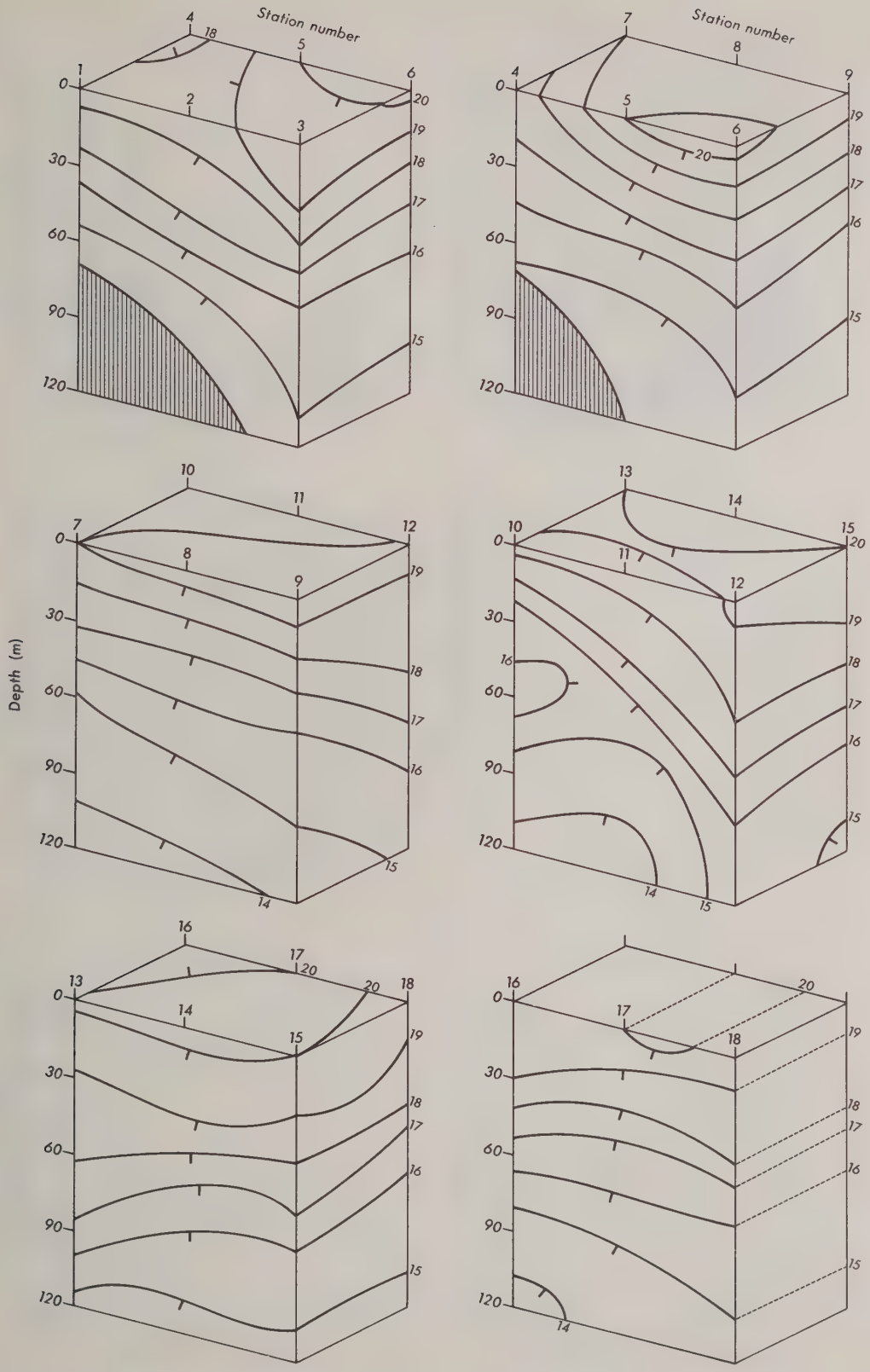


Fig. 2b: Depth profiles of temperature (°C) at stations on skipjack fishing grounds, January. Hatched area represents sea bed.

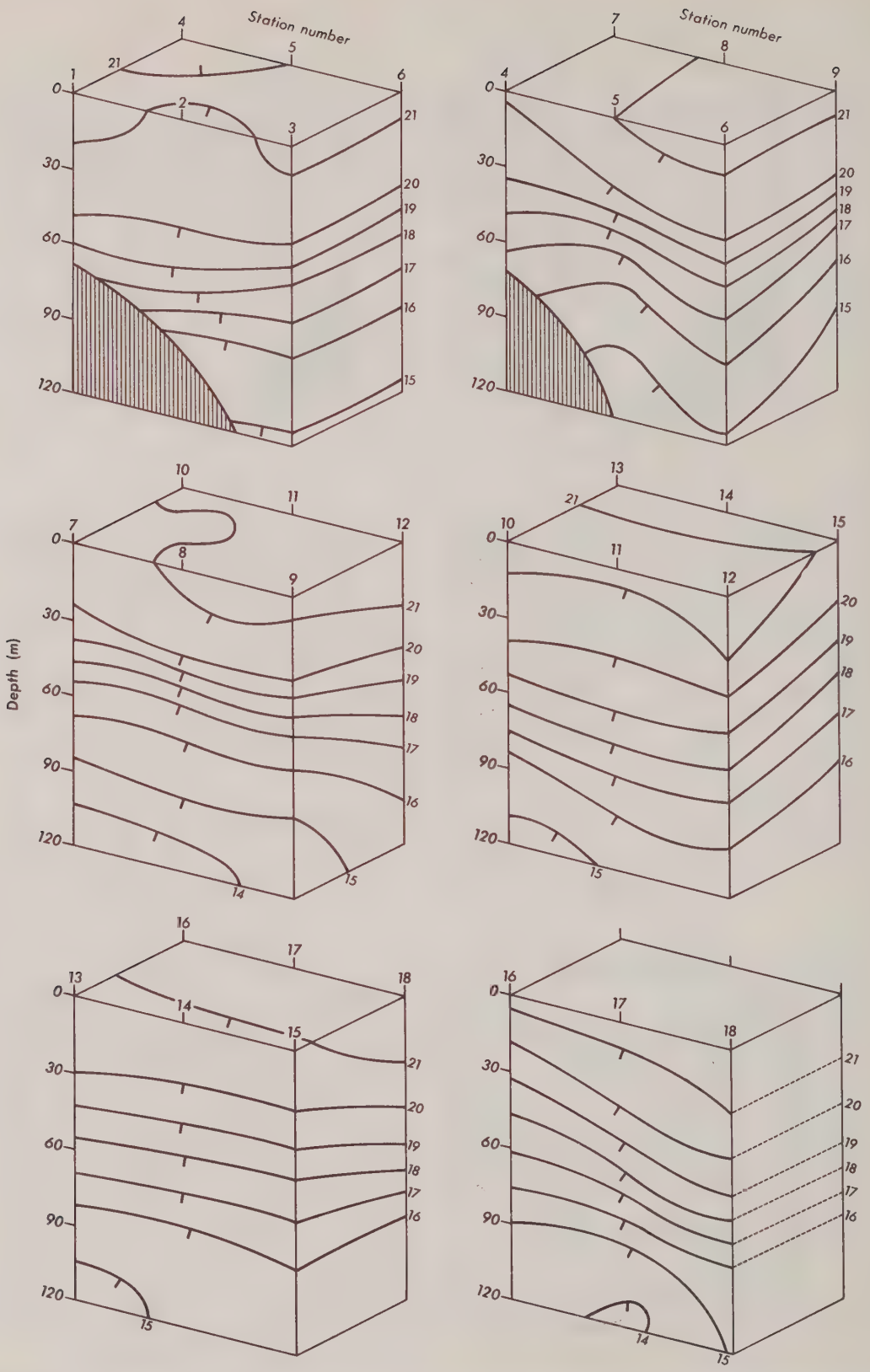


Fig. 2c: Depth profiles of temperature (°C) at stations on skipjack fishing grounds, February. Hatched area represents sea bed.

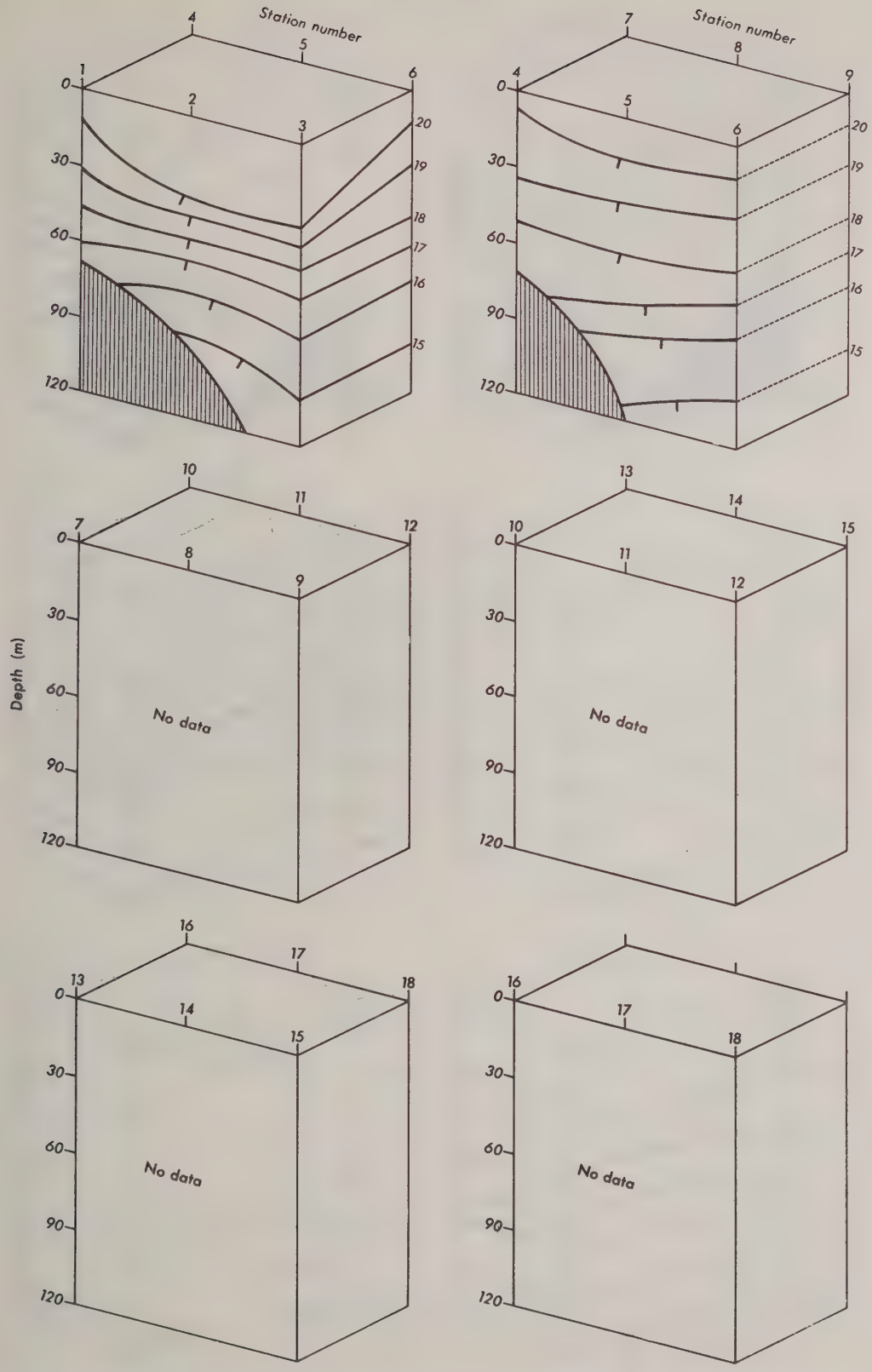


Fig. 2d: Depth profiles of temperature (°c) at stations on skipjack fishing grounds, March. Hatched area represents sea bed.

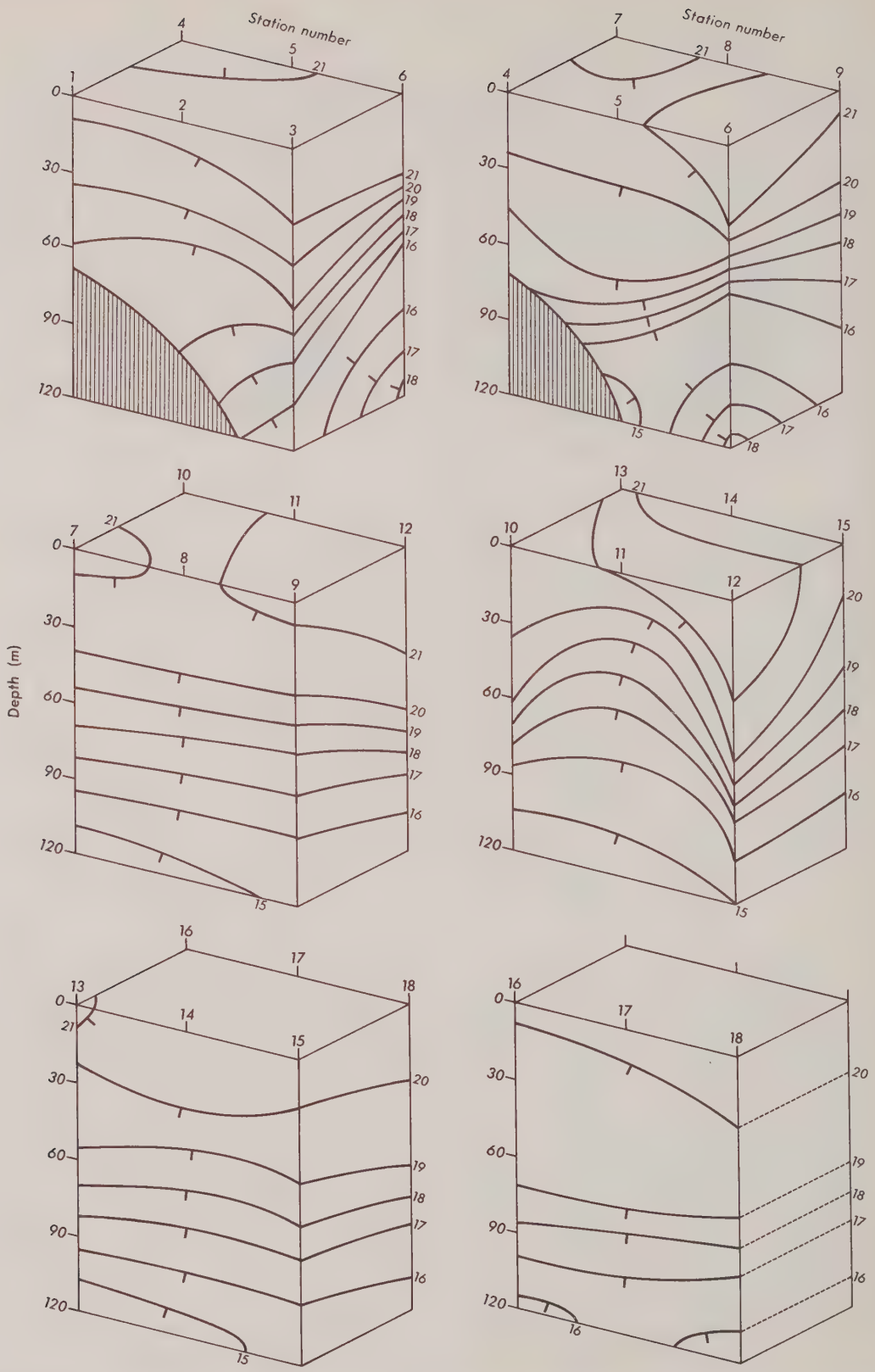


Fig. 2e: Depth profiles of temperature (°c) at stations on skipjack fishing grounds, April. Hatched area represents sea bed.

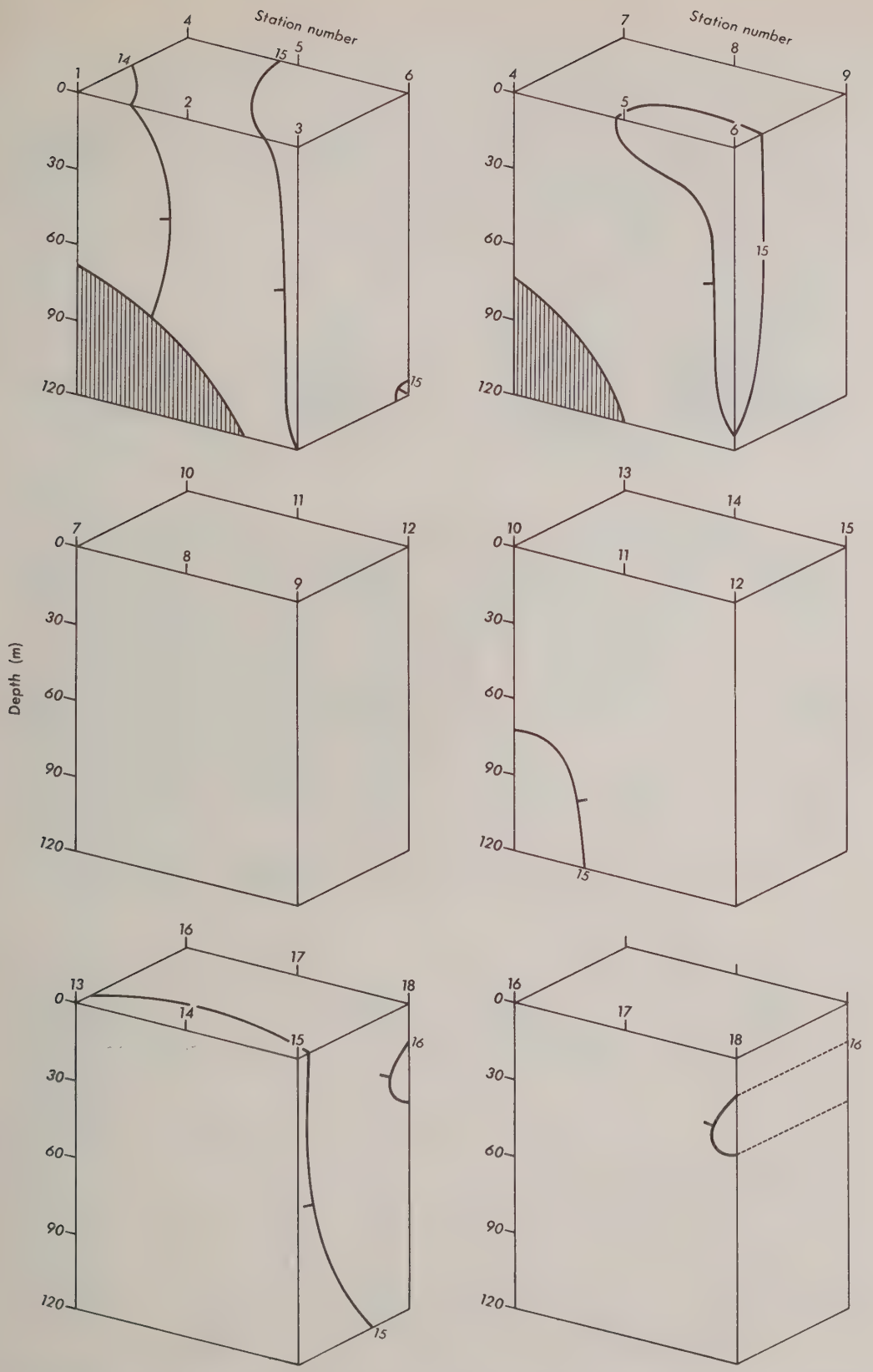


Fig. 2f: Depth profiles of temperature (°C) at stations on skipjack fishing grounds, mid winter. Hatched area represents sea bed.

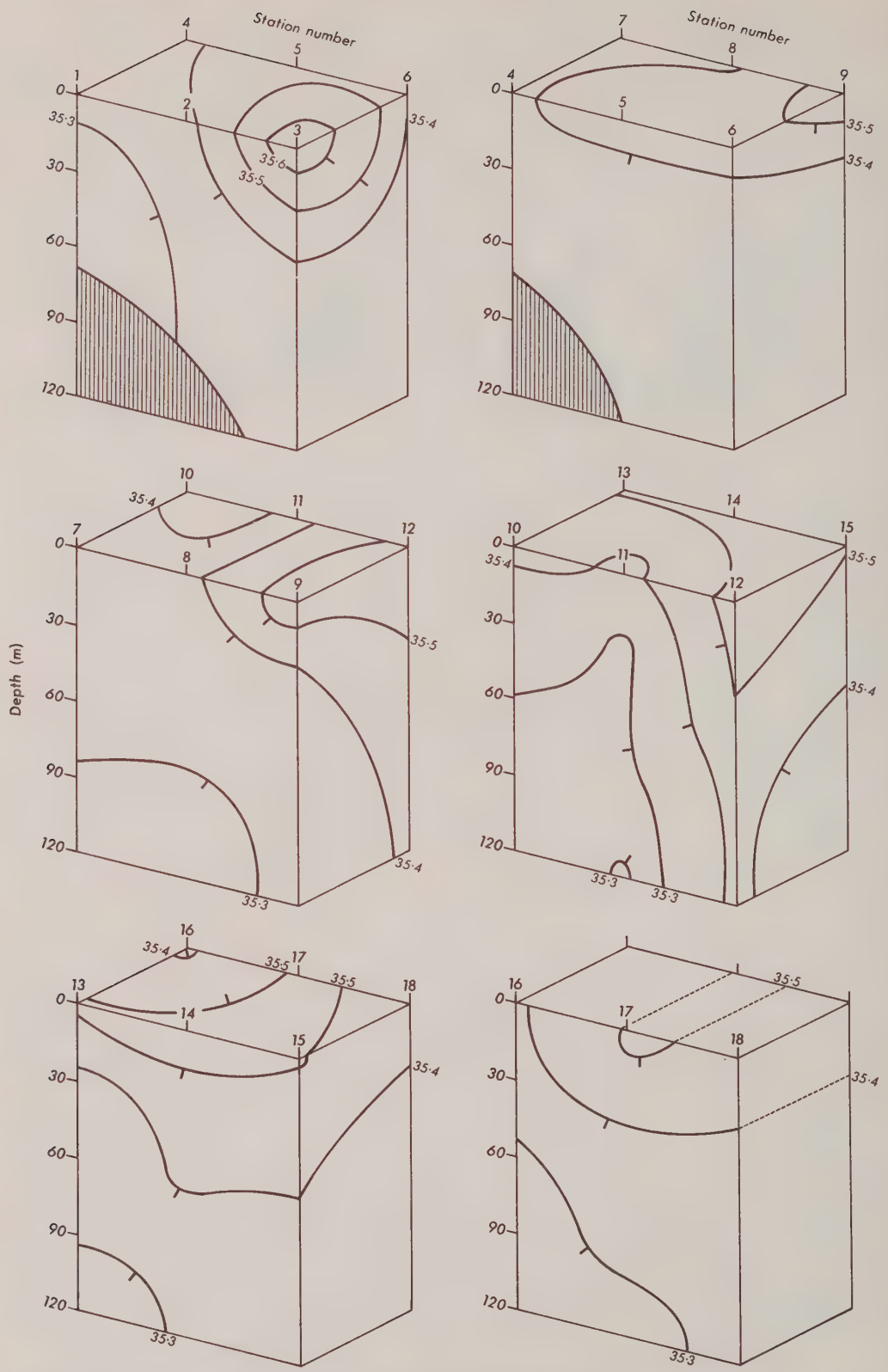


Fig. 3b: Depth profiles of salinity (parts per thousand) at stations on skipjack fishing grounds, January. Hatched area represents sea bed.

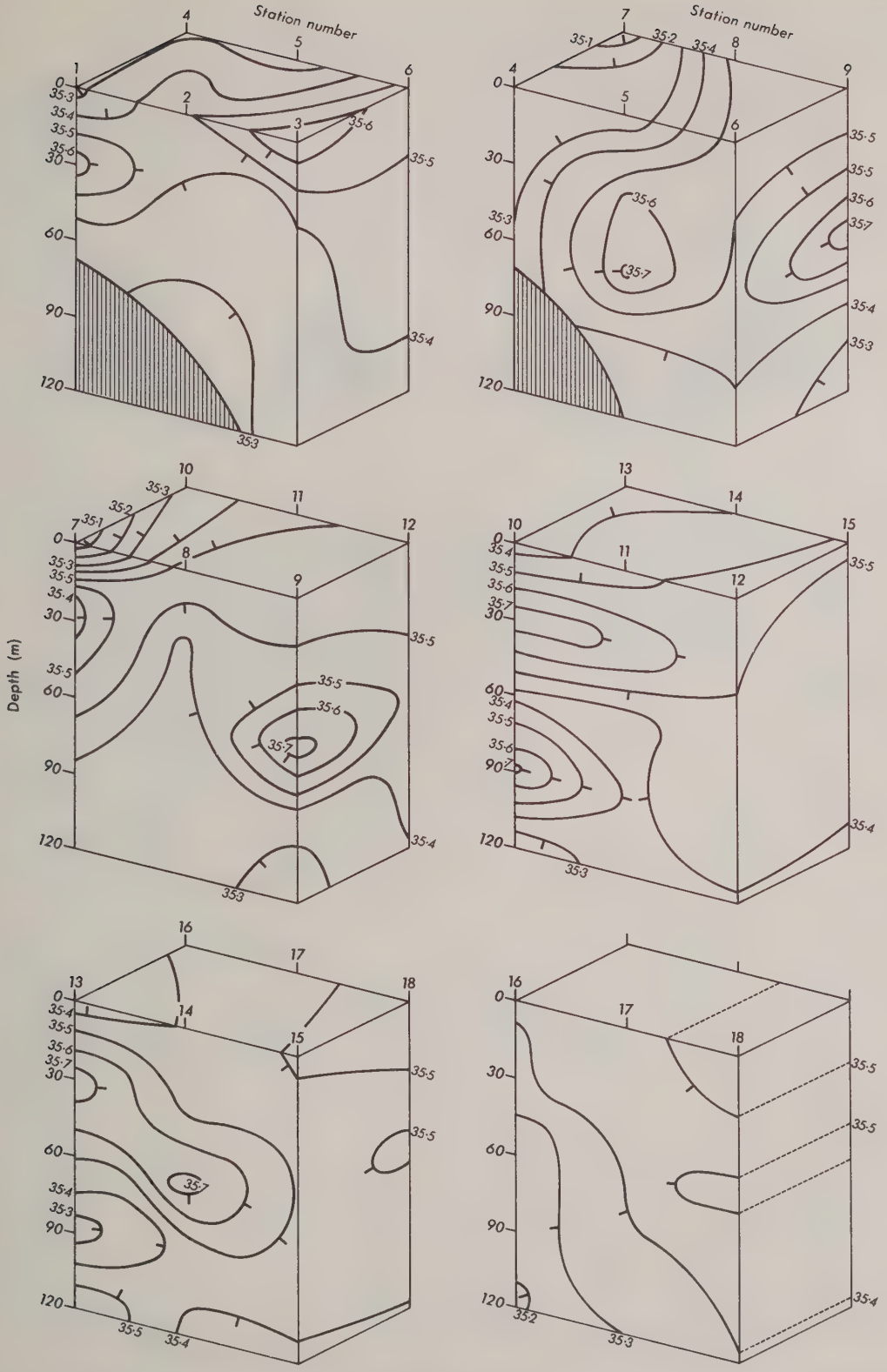


Fig. 3a: Depth profiles of salinity (parts per thousand) at stations on skipjack fishing grounds, December. Hatched area represents sea bed.

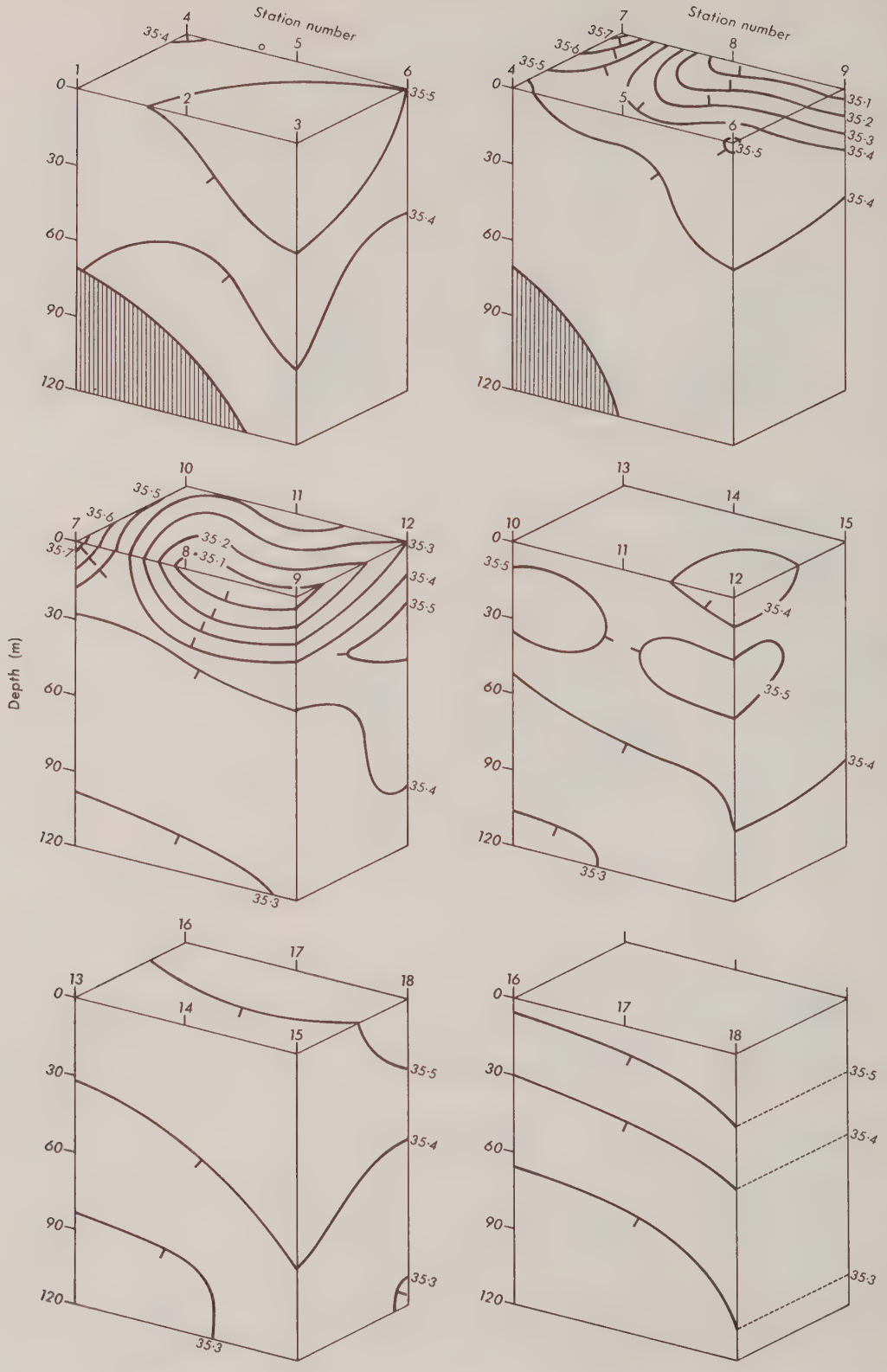


Fig. 3c: Depth profiles of salinity (parts per thousand) at stations on skipjack fishing grounds, February. Hatched area represents sea bed.

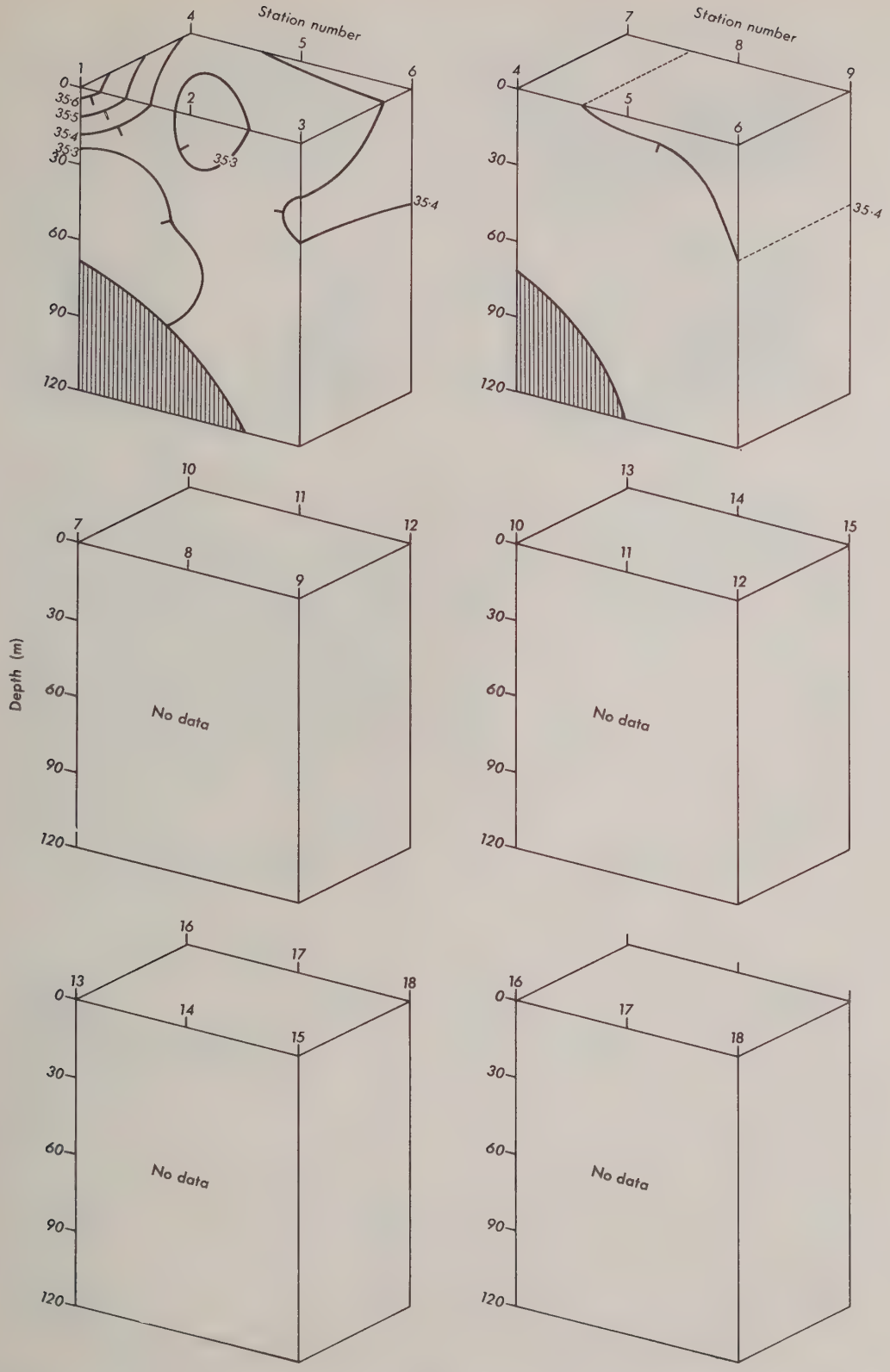


Fig. 3d: Depth profiles of salinity (parts per thousand) at stations on skipjack fishing grounds, March. Hatched area represents sea bed.

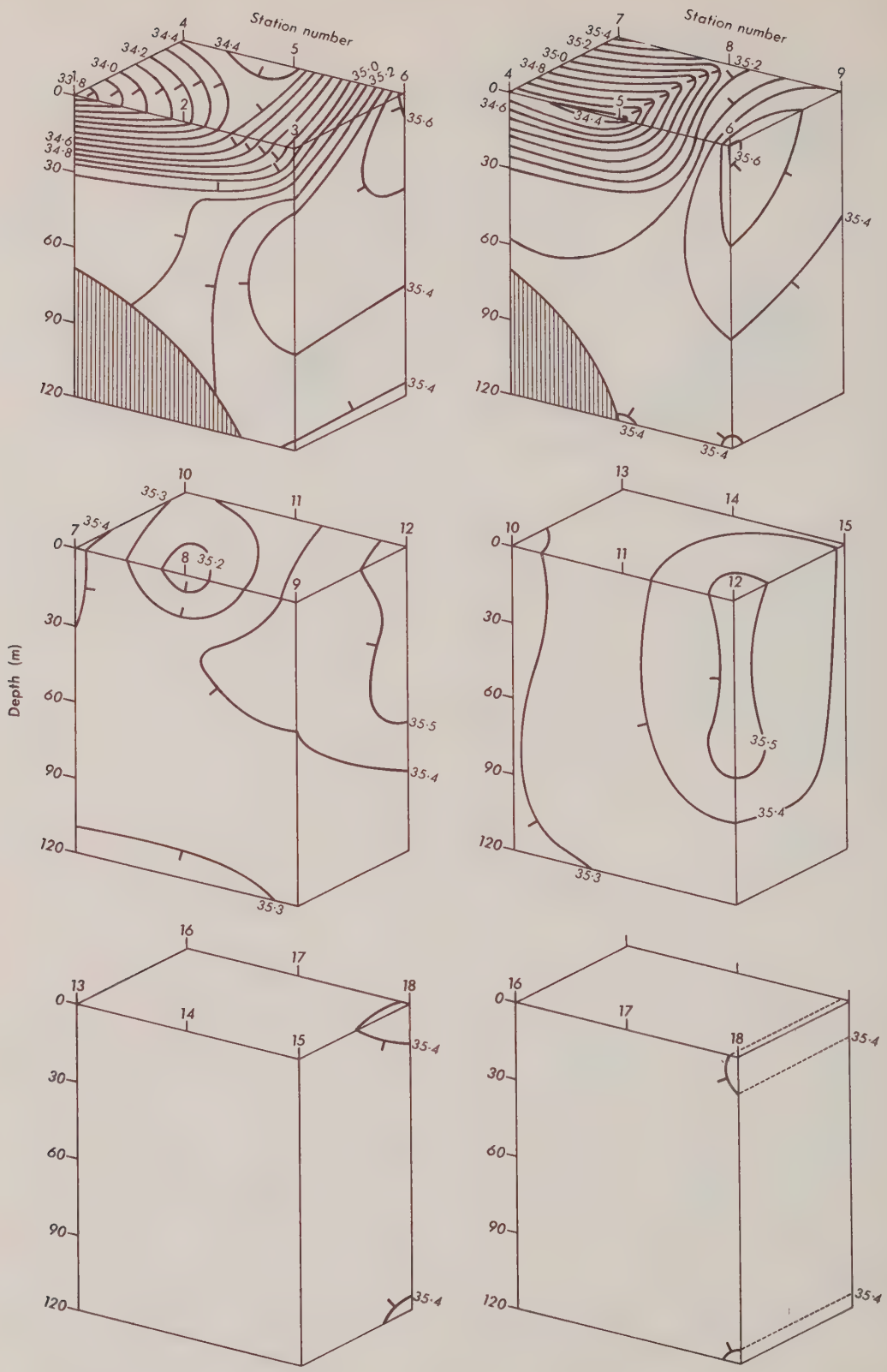


Fig. 3e: Depth profiles of salinity (parts per thousand) at stations on skipjack fishing grounds, April. Hatched area represents sea bed.

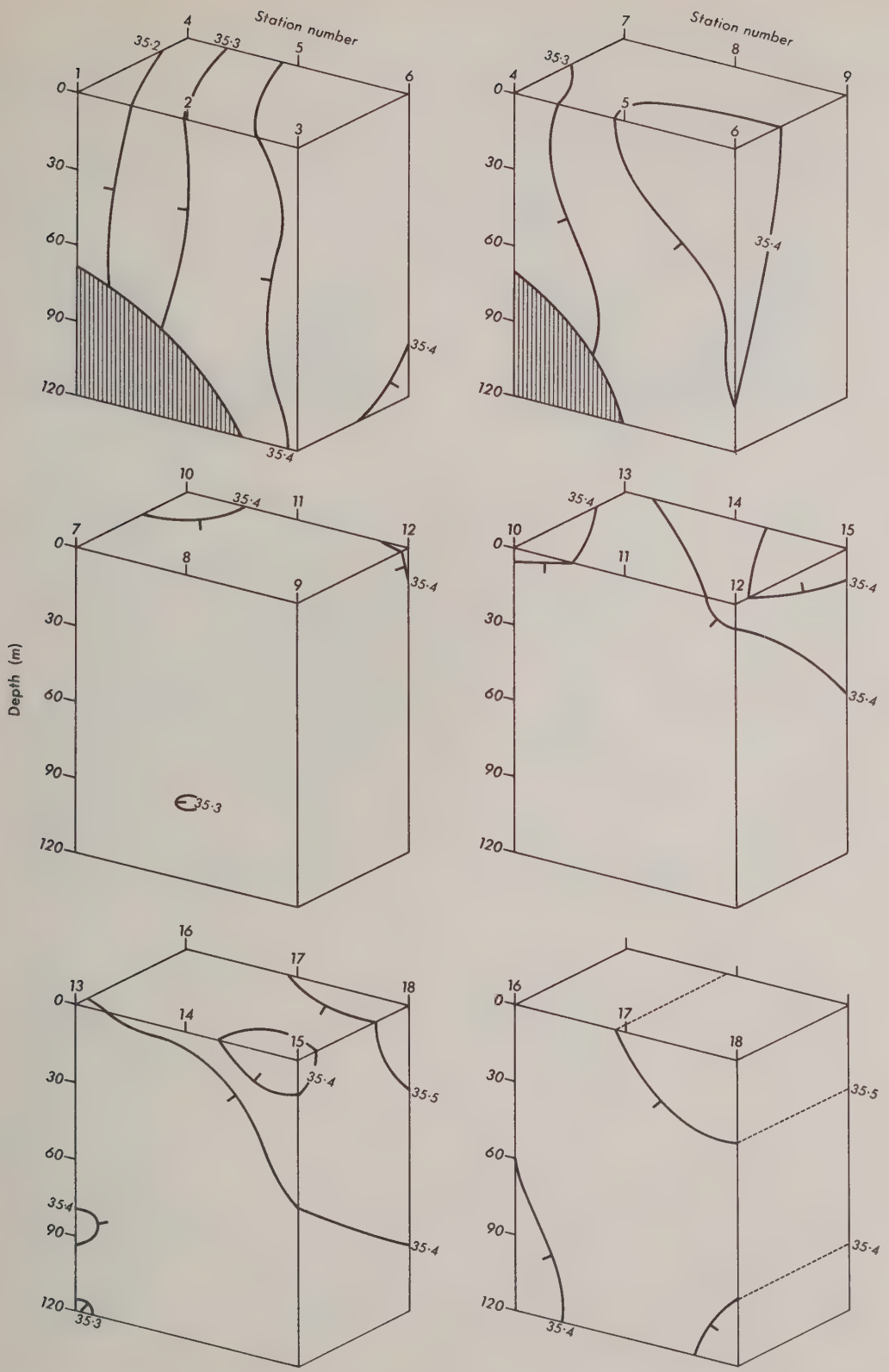


Fig. 3f: Depth profiles of salinity (parts per thousand) at stations on skipjack fishing grounds, mid winter. Hatched area represents sea bed.

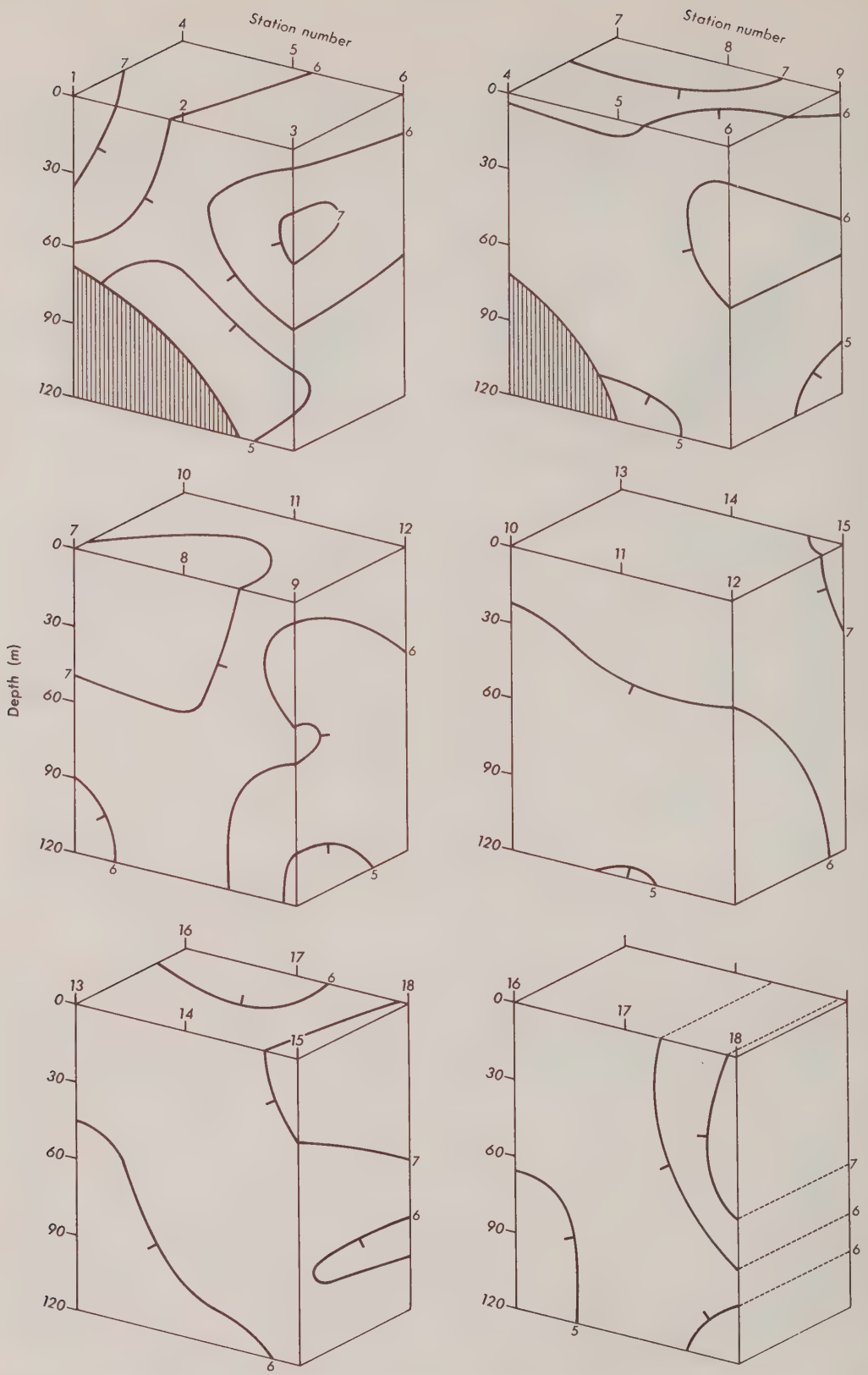


Fig. 4a: Depth profiles of dissolved oxygen (ml/l) at stations on skipjack fishing grounds, December. Hatched area represents sea bed.

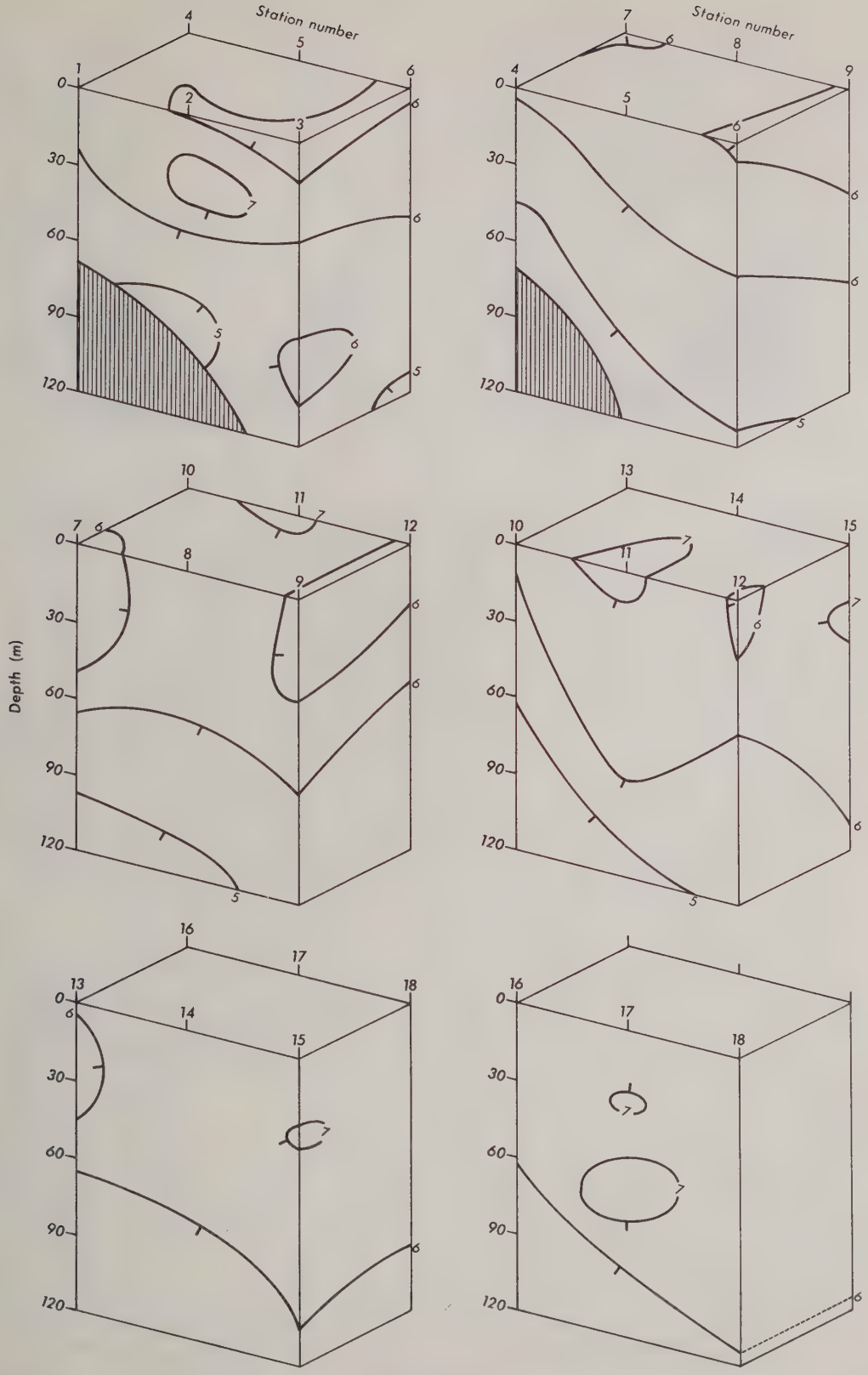


Fig. 4b: Depth profiles of dissolved oxygen (ml/l) at stations on skipjack fishing grounds, January. Hatched area represents sea bed.

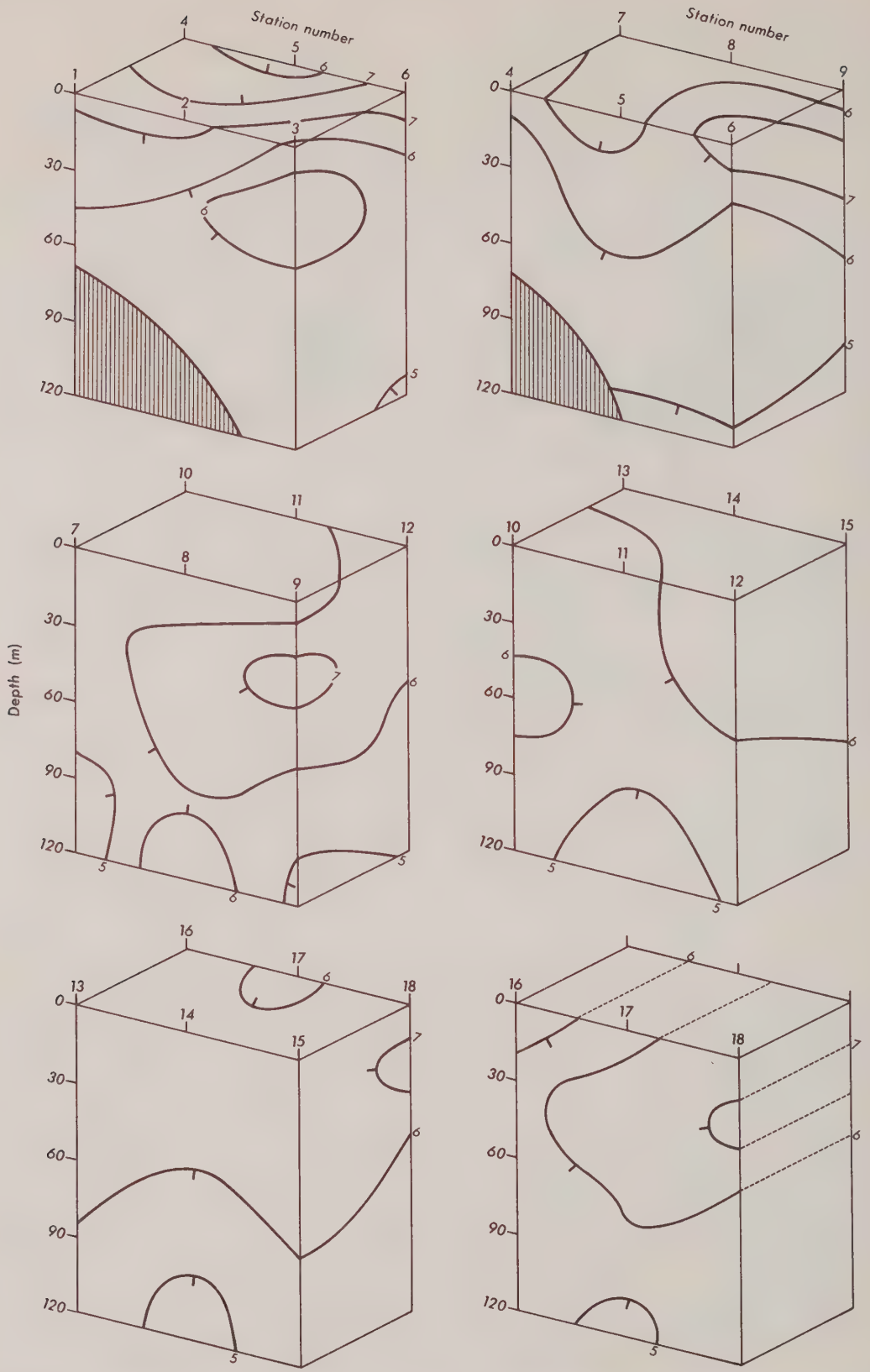


Fig. 4c: Depth profiles of dissolved oxygen (ml/l) at stations on skipjack fishing grounds, February. Hatched area represents sea bed.

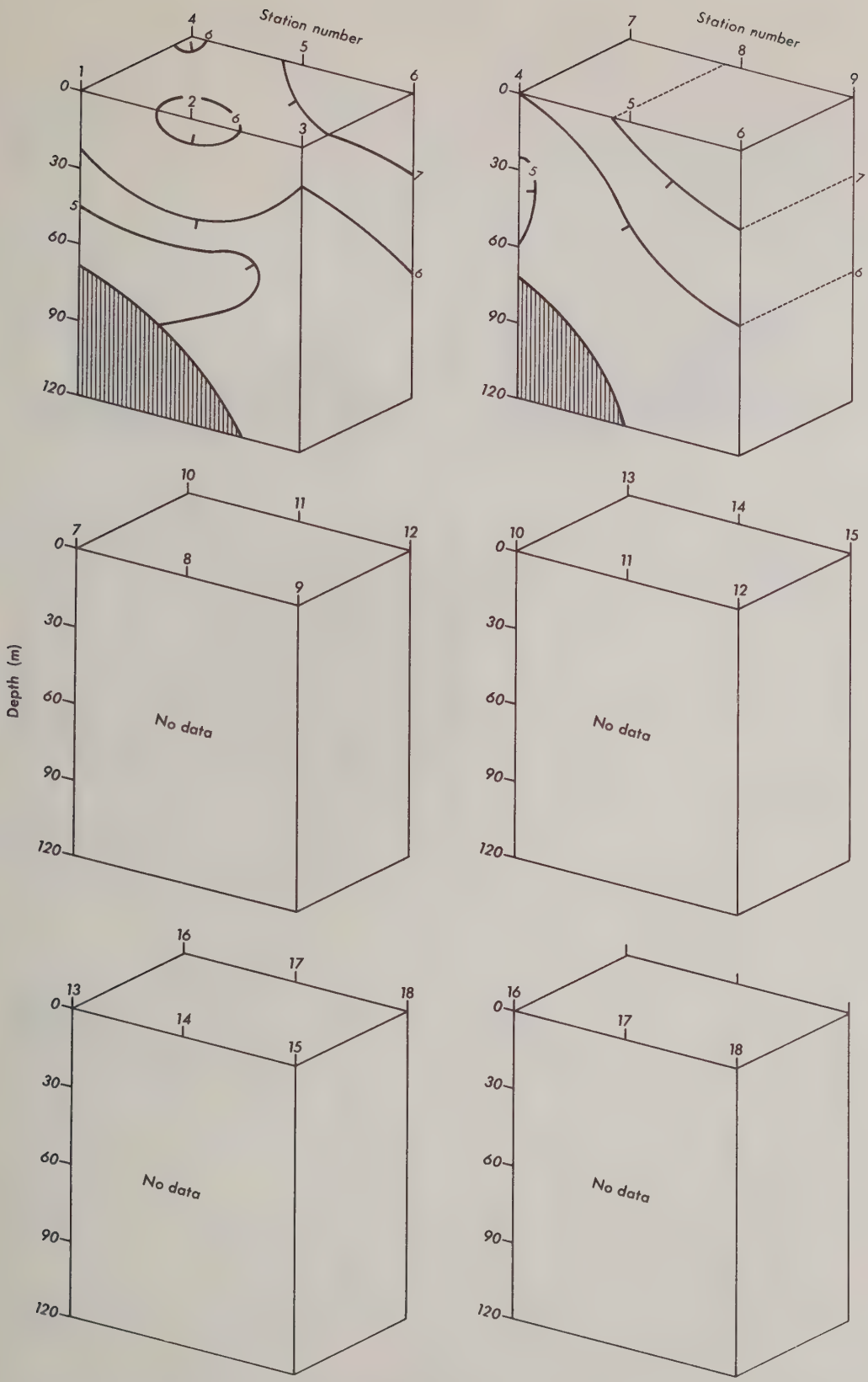


Fig. 4d: Depth profiles of dissolved oxygen (ml/l) at stations on skipjack fishing grounds, March. Hatched area represents sea bed.

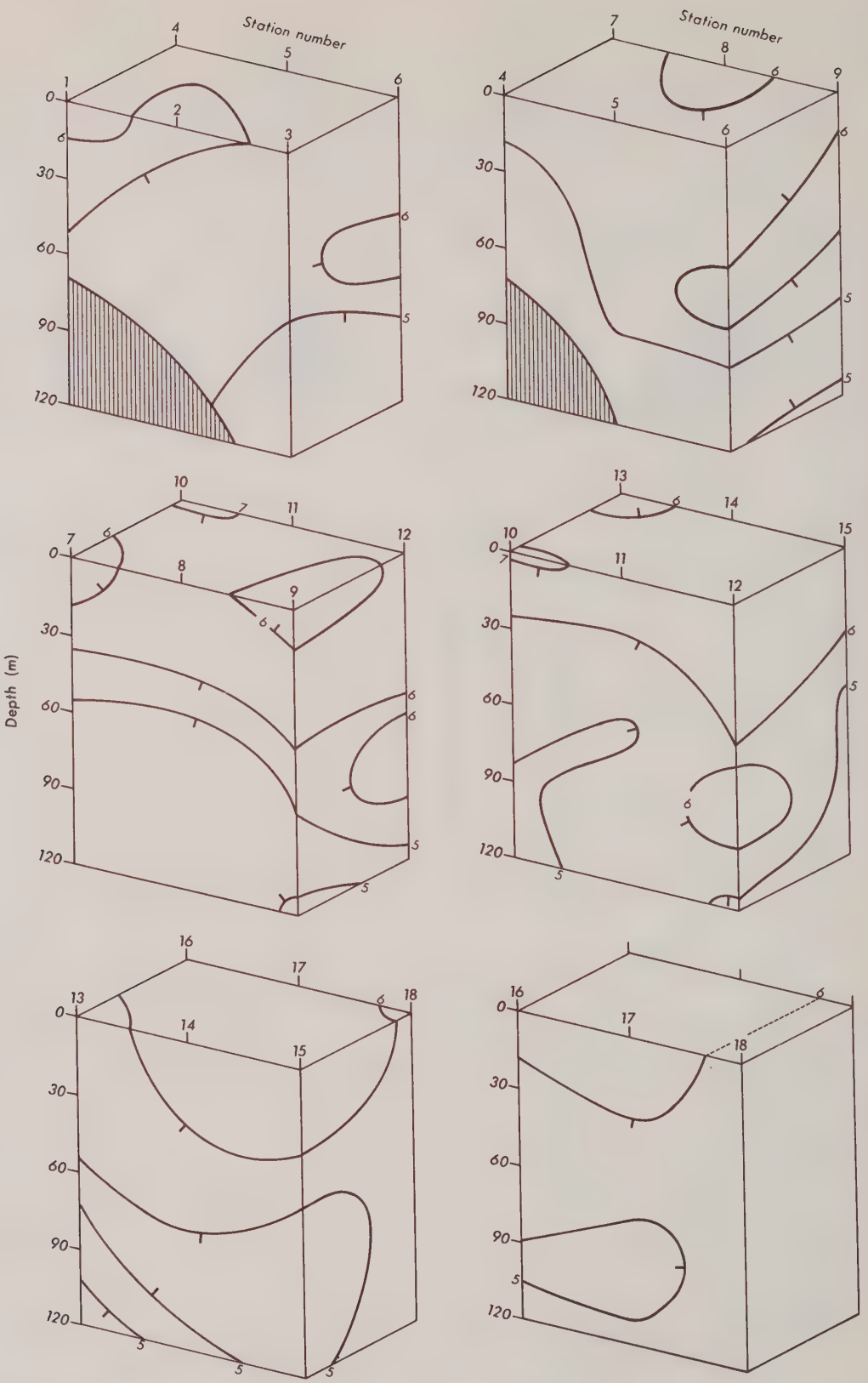


Fig. 4e: Depth profiles of dissolved oxygen (ml/l) at stations on skipjack fishing grounds, April. Hatched area represents sea bed.

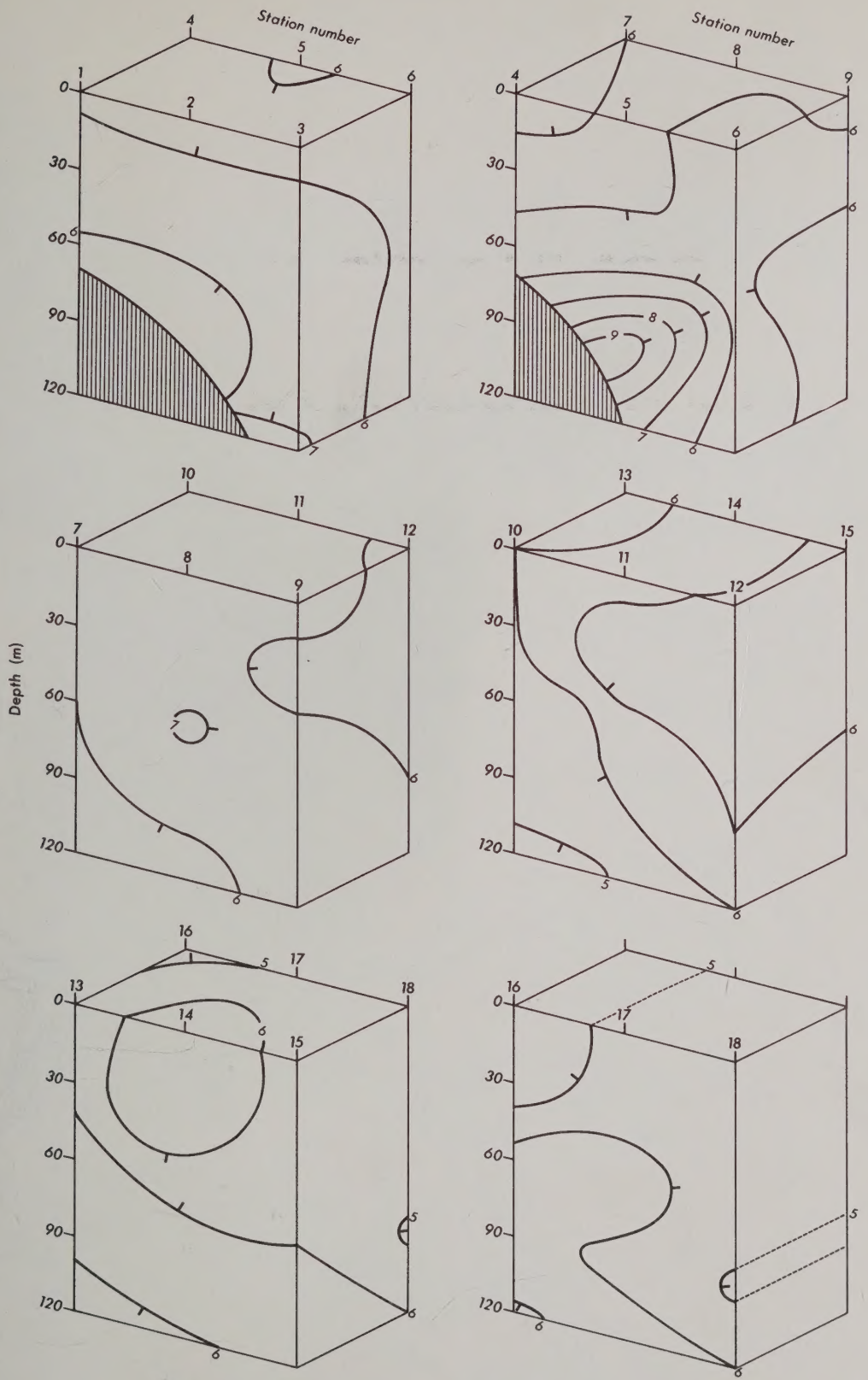


Fig. 4f: Depth profiles of dissolved oxygen (ml/l) at stations on skipjack fishing grounds, mid winter. Hatched area represents sea bed.

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